THE PRACTICE OF PHOTOGRAPHY.

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BY

ROBERT HUNT, F.R.S.,

VICE-PRESIDENT OF THE PHOTOGRAPHIC SOCIETY OF LONDON—AUTHOR OF "RESEARCHES ON LIGHT," "THE POETRY OF SCIENCE," &c.

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PREFACE.

THE "PRACTICE OF PHOTOGRAPHY" will be found to contain every manipulatory detail, carefully described, which it is necessary for the student in this beautiful art to understand. Not merely have the more important processes been given, but several minor ones, of considerable interest, have been included. Those who may be desirous of learning the History of Photographic discovery, or of entering on the study of the philosophy of the subject, are referred to the "Manual of Photography," of which the "Practice," indeed, forms a division.

LONDON, *February*, 1857.

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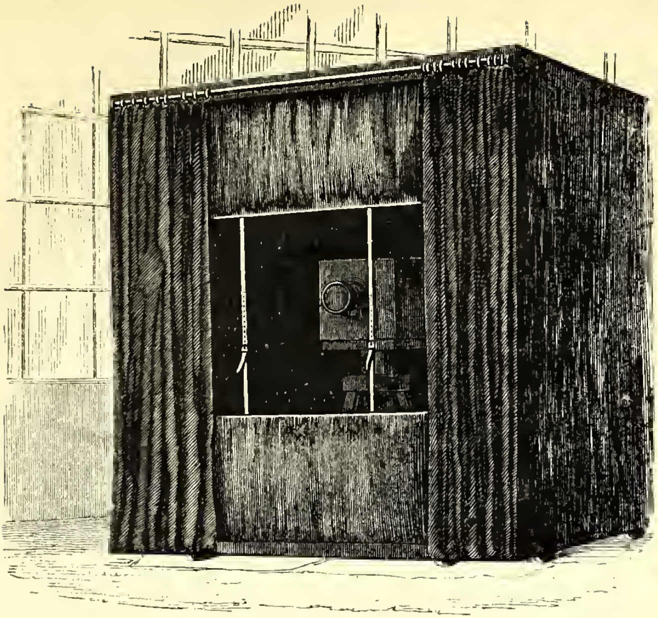

CHAPTER I.

SELECTION OF PAPER FOR PHOTOGRAPHIC PURPOSES.

A PROCESS which involves the most delicate chemical changes, requires more than ordinary care in the selection of the substance upon which its preparations are to be spread. In our photographic processes this becomes the more evident as we proceed to produce increased conditions of sensitiveness. As the material, whatever it may be, is rendered more susceptible of change under solar influence, the greater is the difficulty of producing perfectly uniform surfaces. Paper is so convenient and economical, that it is of the first importance to overcome the difficulties which stand in the way of its use, as the tablet on which the photographic picture is to be delineated.

The principal difficulty we have to contend with in using paper is, the different rates of imbibition which we often meet with in the same sheet, arising from trifling inequalities in its texture and unequal sizing. This is, to a certain extent, to be avoided by a careful examination of each sheet by the light of a lamp or candle at night.

By extending the paper between the light and the eye, slowly moving it up and down, and from left to right, the variations in its texture will be seen, by the different quantities of light which permeate it; and it is always the safest course to reject every sheet in which any inequalities are detected. By day it is more difficult to do this than at night, owing to the interference of the reflected with the transmitted light. It will, however, sometimes happen that paper which has been selected by the above means will still imbibe fluids unequally. In all cases where the paper is to be soaked in saline solutions, we have another method of discovering those sources of annoyance. Having the solution in a broad shallow vessel, extend the paper, and gradually draw it over the surface of the fluid, taking care that it is wetted on one side only. A few trials will render this perfectly easy. As the fluid is absorbed, any irregularities are detected by the difference of appearance exhibited on the upper side, which will, over well-defined spaces, remain of a dull white, whilst other portions will be shining with a reflective film of moisture. Where the importance of the use to which the paper is to be applied will repay a little extra attention, it is recommended to try it by this test with pure water, before it is submitted to the salting operation.

It will be sometimes found that the paper contains minute fibres of thread, arising from the mass of which it is formed not having been reduced to a perfect pulp. Such paper should be rejected, and so also should those kinds which are found to have many brown or black specks, as these materially interfere with some of the processes. Many of the spots in paper are formed by particles of brass wire which have separated from the machinery employed in its manufacture, or they may be fragments of buttons derived from the rags, and minutely divided in the process of pulping. It will be found when any particles of brass or copper are present in the paper, that they become centres of decomposition, when the silver salt is applied. Some specimens of paper have an artificial substance given to them by sulphate of lime (plaster of Paris); but, as these are generally the cheaper kinds, they are to be avoided by purchasing the better sorts. The plaster can be detected by burning a sheet of the paper and weighing the quantity of ash left; pure paper leaving less than $\frac{1}{2}$ per cent. It is the custom of paper-makers to fix their names and the date on one leaf of the sheet of writing paper. This leaf must be rejected, or paper must be selected which is not so marked, as in many of the photographic processes these marks are brought out in annoying distinctness.

From the various kinds of size which the manufacturers use in their papers, it will be found that constantly varying effects will arise. A well-sized paper is by no means objectionable; on the contrary, organic combinations exalt the darkening property of the nitrate and chloride of silver. But unless we are careful always to use the same variety of paper for the same purpose, we shall be much perplexed by the constantly varying results which we shall obtain. With the advancing importance of the art, the demand for paper for photographic purposes has increased, and several manufacturers now prepare papers which are free from the objections named. All who desire to make any progress in photography must take the necessary precautions in the selection of their paper, or be content to meet with repeated failures.

The photographic peculiarities of paper may be said mainly to depend upon the sizes employed. The English paper manufacturers very commonly employ gelatine, and this in different conditions. The French, on the contrary, use starch, and this, from the strong affinity existing between starch and iodine, appears to be one reason why many of the French papers are superior for some of the processes involving the use of iodine.

Resin soap is largely employed as a size. The soap is applied to the bibulous paper, and then decomposed by acidulated water, leaving a fine film of resin spread upon the surface, which is susceptible of the highest polish.

Unsized paper has been recommended by some, but in no instance have I found it to answer so well as paper which has been sized. The principal thing to be attended to in preparing sensitive sheets—according to my experience, extended over a long period, although it is opposed to the views of some young but able photographers—is to prevent, as far as it is possible, the *absorption of the solutions into the body of the paper—the materials should be retained as much as possible upon the very surface.* Therefore the superficial roughness of unsized sheets, and the depth of the imbibitions, are serious objections to their use. It must not, however, be forgotten, that these objections apply in their force only to the preparations of silver.

Great annoyance often arises from the rapid discolouration in the dark of the more sensitive kinds of photographic drawing paper, which appears to arise from the action on the nitrate of silver of the organic matter of the *size.* If we spread pure chloride of silver over paper, it may be kept without any change of its whiteness taking place. Wash it over with a solution of nitrate of silver, and, particularly if the paper is much sized, a very rapid change of colour will take place, however carefully we may screen it from the light. From this it is evident that the organic matter is the principal cause of the spontaneous darkening of photographic papers prepared with the salts of silver.

The most curious part of the whole matter is, that in many cases this change is carried on to such an extent that a revival of metallic silver takes place, to all appearance in opposition to the force of affinity. This is very difficult to deal with. I can only view it in the following light—the nitric acid liberates a quantity of carbonaceous matter from the paper, which, acting by a function peculiarly its own, will at certain temperatures effect the revival of gold and silver, as shown by Count Rumford's experiments.

Having been informed that the paper-makers are in the habit of bleaching their papers with sulphur and sulphites, I submitted a considerable quantity of the browned papers to careful examination. In all cases where the paper, covered with chloride of silver, rapidly *blackened*, I detected the presence of sulphur. Consequently, when the darkening goes on rapidly, and terminates in blackness, we may, I think, correctly attribute it to the formation of a sulphide of silver.

It is, however, certain that the slow action of organic matter is sufficient, under certain circumstances, to set up a chemical change, which, once started, progresses slowly, but certainly, until the compound is reduced to its most simple form.

China clay—*kaolin*—has of late years been much used by the paper manufacturers, for the double purpose of giving weight to the paper, and of enabling them to produce a smooth surface upon all the finer varieties of paper; such as the enamelled satin post. This compound of alumina and silica would not, if the finest varieties of clay were employed, be likely to do much mischief in the papers used for photography; but the less pure varieties of the Cornish clay are employed, and this commonly contains the oxides of iron and other metals in a state of very fine division; and these, where they come to the surface, form little centres of action, from which dark circles spread in rather a curious manner.

Thin papers have been tried, and many varieties would answer exceedingly well, but that nearly all kinds are found penetrated with small holes, which, though of minute dimensions, suffer light to pass freely, and consequently produce a spottiness on the resulting picture. Sir John Herschel found that this evil could be remedied by fastening two pieces of such paper together; but this method is troublesome and uncertain.

The importance of the selection of paper as chemically pure as possible cannot be over-estimated, and all who aim at excellence in any of the photographic processes should carefully attend to all the precautions indicated as necessary.

CHAPTER II.

ON THE APPARATUS NECESSARY FOR THE FIRST PRACTICE OF PHOTOGRAPHY.

The most simple method of obtaining sun-pictures, is to place the object to be copied on a sheet of prepared paper, to press them close by a piece of glass, and then to expose the arrangement to sunshine. All the parts exposed, darken, while those covered are protected from change, the resulting picture being *white* upon a *dark ground.*

It should be here stated, once for all, that such pictures, howsoever obtained, are called *negative photographs;* and those which have their lights and shadows correct as in nature—*dark* upon a *light ground*, are called *positive photographs.*

The accompanying woodcut, fig. 12, represents the *negative* copy of leaves, and fig. 13, the *positive* copy obtained from the first by a process to be presently described.

Fig. 12.

Fig. 13.

If a photograph of any illuminated object is obtained by means of the camera obscura, the picture being produced by the darkening of a white or yellow paper, it will be evident that the *highest lights* will be represented as *dark portions*, and the *shadows* as *lights*. Thus we obtain a *negative image*. The female figure in the adjoining woodcut, fig. 14, is copied from a calotype *negative* portrait; and from this negative is obtained the *positive* in which the lights and shades are natural, as in the second figure, fig. 15.

Fig. 14.

Fig. 15.

For the production of photographic drawings, it is necessary to be provided with a COPYING FRAME AND GLASS. The size of this copying frame may vary at the will of the operator, as he may desire to copy large or small objects. The glass must be of such thickness as to resist some considerable pressure, and it should be selected as colourless as possible, great care being taken to avoid any tint of yellow or red, these colours preventing the permeation of a large proportion of the most efficient rays. Figures 16 and 17 represent such a frame in its most simple form; the first showing it in front, as it is employed in taking a copy of leaves, and the other the back, with its board, and its brass bar, which, when pressed into angular apertures in the sides of the frame, gives the required pressure to the paper.

Fig. 16.

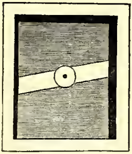

Fig. 17.

Between the board and the glass there must be a cushion of some yielding substance such as flannel or velvet, the object of this being to secure close contact between the object which we desire to copy, and the paper upon which it is to be copied.

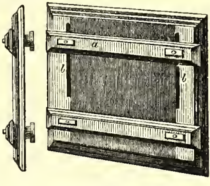

Fig. 18.

For all ordinary uses, this frame answers well; but a more convenient pressure frame is constructed in the manner represented by fig. 18. This contains two bars, one of them moveable, and both of them may be fixed in any required position by binding screws.

In arranging botanical specimens, the under surface of the leaves should be next the glass, their upper and smooth surface in contact with the paper. Although very beautiful copies may be taken of dried specimens, they bear no comparison with those from fresh gathered leaves or recently collected plants; of which, with the most delicate gradations of shades, the veins of the leaves, and the down clothing the stems, are exhibited with incomparable fidelity. In the event of the plant having any thick roots or buds, it will be best to divide them with a sharp knife, for the purpose of equalizing the thickness in all parts, and insuring close contact.

Engravings are to be placed with their faces to the prepared side of the photographic paper, laid very smoothly on the glass, and then, by the cushion and back, pressed into the closest contact possible: the least difference in the contact, by permitting dispersion, occasions a cloudiness and want of sharpness in the photograph.

Of course a copy of anything taken by means of the rays which have passed *through* it, must present all the defects as well as all the beauties of the object, whatever it may be. Thus, in copying a print, we have, besides the lines of the engraving, all the imperfections of the paper. This renders it necessary that those engravings should be selected which are as transparent as possible. If the preservation of the engraving is not a matter of much moment, by washing it over the back with a varnish of Canada balsam and spirits of turpentine, it is rendered highly transparent, and the resulting impression is much improved. Care must, however, be taken to use the varnish very thin, that it may not impart any yellow tinge to the paper. An exposure of a few minutes only is sufficient to produce strong and faithful copies during sunshine; but in diffused daylight a longer period is necessary.

The copying frame is an indispensable requisite to the photographer: it is used for copying all objects by transmission, and for multiplying the original pictures, obtained by means of the camera obscura from nature: it is, indeed, the printing-press of the artist. Some prefer two plates of stout plate-glass pressed very closely together with clamps and screws; but as the intention is to bring the object to be copied and the sensitive paper into the closest possible contact, numerous mechanical contrivances will suggest themselves for this purpose to the ingenious.

A great number of experiments should be made with the copying frame before there is any attempt at using the *camera obscura*.

The most important instrument to the photographer is the Camera Obscura, therefore it should be well understood, and selected with judgment.

The camera obscura or *dark chamber* was the invention of Baptista Porta of Padua. Its principles will be best understood by the very simple process of darkening a room, by closing the window-shutters, and admitting a pencil of light through a small hole. If a screen is placed at some distance from the hole the images of external objects, inverted, will be seen delineated upon it. By putting a small lens over the hole, these images are rendered smaller, but more distinct, from the more perfect refraction of the rays by the spherical glass.

If, instead of a darkened room, we substitute a darkened box, the same effect will be seen. Suppose, in the first place, the box to have merely a small hole in one end of it, the rays from the external object would pass in nearly right lines through the opening, being refracted slightly in passing the solid edges of the hole, and form an image on the back of the dark box. We now place a small lens over the hole—the lens refracts the rays still more, and a smaller, but a more perfectly defined picture, is the result. This is virtually the camera obscura which the photographer has to employ.

In the ordinary cameras used by artists for sketching, a mirror is introduced, which throws the image on a semitransparent table.

Fig. 19 is a section of one form of such an instrument: *a à* represents the box, in one end of which is fixed the lens *b*. The lenticular image falls on the mirror *c*, placed at such an angle that it is reflected up to the plate of ground-glass *d*. *e* is a screen to prevent the overpowering influence of daylight, which would render the picture almost invisible. This form of the apparatus, though very interesting as a philosophical toy, and extremely useful to the artist, is by no means fitted for photographic purposes. The radiations from external objects always suffer considerable diminution of chemical power in penetrating the lens, and the reflection from the mirror and transmission through the glass table *d* so far reduce their intensity, that the action on photographic agents is slow.

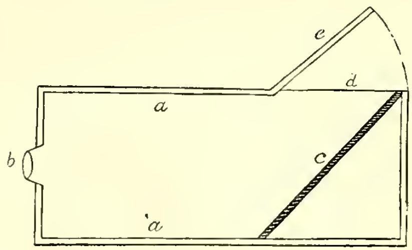

Fig. 19.

A great variety of these instruments have been introduced to the notice of students of the art of photography.

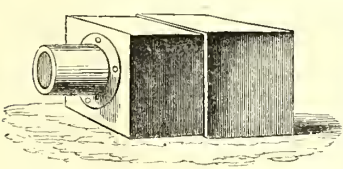
Fig. 20.

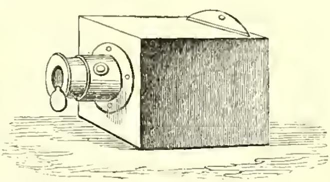
Fig 21.

It is conceived, therefore, that a few examples of portable and convenient cameras will not be out of place. Fig. 20 represents one box sliding within the other for the purpose of adjusting the focal distances, the lens being fitted into a brass tube, which screws into the front of the camera. The woodcut (fig. 21) is but one box, the lens being fitted into one brass tube sliding in another, like a telescope tube, moving by means of a screw and rack. The mouth of the tube is contracted, by which any adventitious radiations are obstructed, and a brass shade is adjusted to close the opening if required; the paper is placed in a case fitted with a glass front, as in fig. 22, and a shutter, by which it is protected from the light until the moment it is required to throw the image upon it.

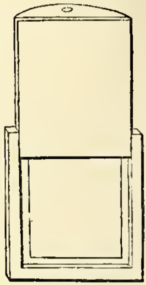

Fig. 22.

The following figures (figs. 23, 24, 25) represent a more perfect arrangement. The advantages are those of folding, and thus packing into a very small compass, for the convenience of travellers. This camera obscura is, however, only adapted for landscapes.

With the camera obscura properly arranged, and the copying frame, the photographic student who confines his attention to the processes on paper has nearly all he requires. For the convenience of adjusting the instrument to different heights, and to different angles of elevation, tripod stands are almost indispensable. They are made in several ways; the two figures 26 and 27

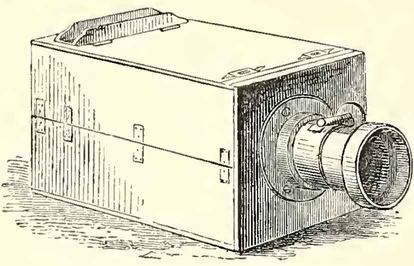

Fig. 23.

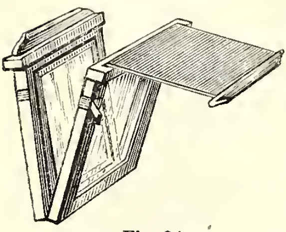

Fig. 24.

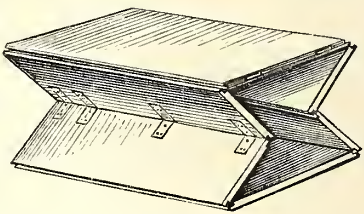

Fig. 25.

representing those which appear best adapted to the use of the traveller. The arrangement of compound legs shown in the first insures greater steadiness than the other; but the range of movement in the second gives it some advantages.

Beyond these things, a few dishes, such as are represented in fig. 28, A A; and a frame B, upon which a photograph can be placed for the purpose of being washed, are the only things required for the practice of photography, except those pieces of apparatus, which, belonging to special processes, will be found described in the chapters devoted to them. The object has been in this chapter to describe those only which are necessary for an amateur to make his rudimentary experiments.

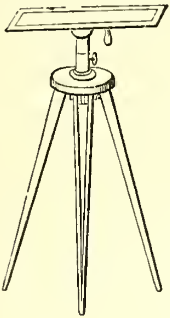

Fig. 26.

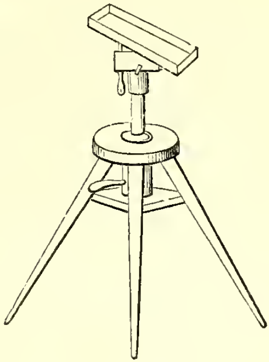

Fig. 27.

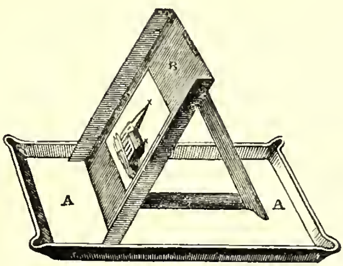

Fig. 28.

CHAPTER III.

ON THE PREPARATION OF SIMPLE SENSITIVE PAPERS.

THE only apparatus required by the young photographer for the preparation of his sensitive papers, are—some very soft spunge brushes and large camel hair pencils (no metal should be employed in mounting the brushes, as it decomposes the silver salts), a wide shallow vessel capable of receiving the sheets of paper without folds, a few smooth planed boards, sufficiently large to stretch the paper upon, and a porcelain or glass slab. He must supply himself with a quantity of good *white* blotting-paper, and several pieces of soft linen or cotton cloth; a box of pins; a glass rod or two; some porcelain capsules, beaker glasses, graduated measures, scales, and weights.

The young photographer should, before he advances to the use of the camera obscura, make himself thoroughly familiar with the more simple processes of copying by superposition. Although by the extreme simplification of some of the highly sensitive photographic processes, it may be easy to obtain pictures in the camera obscura; yet the difficulties of the so-called "*printing processes*" will be a continued source of annoyance, unless there has been considerable experience gained by practising with the copying frame.

I would advise the amateur to start upon his studies with those preparations only:—

1. Chloride of Sodium (*common salt*).
2. Nitrate of Silver, Crystallized.
3. Hyposulphite of Soda.

Nitrate of Silver—Being dissolved in distilled water in the proportion of sixty grains to the fluid ounce, may be employed to prepare the most simple kind of photographic paper. For many purposes this answers well, particularly for copying lace or feathers; and it has this advantage, that it is perfectly fixed by well soaking in warm water, free from salt.

Care must be taken to apply this solution equally, with a quick but steady motion over every part of the paper. It will be found the best practice to pin the sheet by its four corners to one of the flat boards above-mentioned, and then, holding it with the left hand a little inclined, to sweep the brush, from the upper outside corner, over the whole of the sheet, removing it as seldom as possible. The lines in fig. 29 will represent the manner in which the brush should be moved over the paper, commencing at *a* and ending at *b*. On no account must the lines be brushed across, nor must we attempt to cover a spot which has not been wetted, by the application of fresh solution to the place, as it will, in darkening, become a well defined space of a different shade from the rest of the sheet. The only plan is, when a space has escaped our attention in the first washing, speedily to go over the whole sheet with a more dilute solution. It is, indeed, always the safest course to give the sheet two washings.

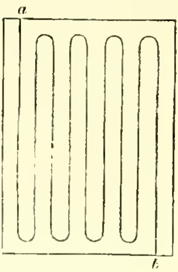

Fig. 29.

This *simple nitrated paper* not being very sensitive to luminous agency, it is desirable to increase its power. This may be done to some extent by availing ourselves of the fact that nitrate of silver combines with organic matter, and is more readily reduced when thus combined.

By washing the paper with a solution of isinglass or parchment size, or by rubbing it over with the white of egg, and immediately applying the sensitive wash, the surface will be found to blacken much more readily, and assume different tones of colour, which may be varied at the taste of the operator, by changing the organic substance employed.

By dissolving the nitrate of silver in spirits of wine, instead of water, we produce a tolerably sensitive nitrated paper, which darkens to a very beautiful chocolate brown; but this wash must not be used on any sheets prepared with isinglass, parchment, or albumen, as these substances are coagulated by alcohol, and wash up, forming streaks over the paper.

Nitrate of silver is not sufficiently sensitive to change readily in diffused light; consequently it is unfit for use in the camera obscura, and it is only in strong sunshine that a copy of an engraving can be taken in any moderate time.

Ammonio-Nitrate of Silver—Is an exceedingly useful preparation for many purposes. It is prepared by adding ammonia to a solution of nitrate of silver: a deep olive precipitate of oxide of silver takes place; more ammonia should then be added, drop by drop, until this precipitate is redissolved, great care being taken that no more ammonia is added than is necessary to effect a perfect re-solution of the oxide of silver. This preparation is more sensitive than the nitrate, and may be used with advantage for copying by superposition; it is, indeed, very frequently employed in taking positive pictures.

Chloride of Silver—Is one of the most important salts employed in photography; it therefore demands especial attention.

Chloride of Silver, whether on the paper, or in a precipitating glass, is formed by a process of double decomposition. Common Salt is *Chlorine* and *Sodium* (*Chloride of Sodium*). Nitrate of Silver is *Nitric Acid* with *Silver*. By bringing solutions of these salts together, the chlorine leaves the sodium and unites with the silver, forming a white salt, insoluble in water, while the nitric acid unites with the sodium, forming a salt soluble in water.

Muriated Papers, as they are termed, are formed by producing a chloride of silver on their surface, by washing the paper with the solution of chloride of sodium (*muriate of soda, common salt*), or any other chloride, and when the paper is dry, with a solution of nitrate of silver.

It is a very instructive practice to prepare small quantities of solutions of common salt and nitrate of silver of different strengths, to cover slips of paper with them in various proportions, and then to expose them altogether to similar solar radiations. A curious variety in the degrees of sensibility, and in the intensity of colour, will be detected, showing the importance of a very close attention to proportions, and also to the modes of manipulating.

Different ways of applying the salts should be tried. In one case apply first the nitrate of silver, and then the chloride of sodium; in another reverse this order; in a third, apply 1st, nitrate of silver, 2d, chloride of sodium, 3d, nitrate of silver again. Then try another experiment, commencing with the salt, then nitrate of silver, then salt again, and lastly, nitrate of silver.

It is presumed that the photographic amateur will perceive that the object is to obtain papers, in which the chloride of silver is mixed with more or less nitrate of silver, and decomposed. The presence of nitrate of silver in excess with the chloride is important; this should be studied. As a means by which the effect of the nitrate may be observed, precipitate upon a glass plate, some chloride of silver, and allow it to dry, then drop upon one portion of the plate, some of the solution of nitrate of silver, and expose it to daylight. It will be found, that while all that portion over which the solution has diffused itself darkens with facility; but very small change takes place over the parts which are covered with the pure chloride of silver.

A knowledge of these preliminary but essential points having been obtained, the preparation of the paper should be proceeded with; and the following method is recommended:—

Taking some flat deal boards, perfectly clean, pin upon them, by their four corners, the paper to be prepared; observing the two sides of the paper, and selecting that side to receive the preparation which presents the hardest and most uniform surface. Then, dipping one of the sponge brushes into the solution of chloride of sodium, a sufficient quantity is taken up by it to moisten the surface of the paper without any hard rubbing; and this is to be applied with great regularity. The papers being "*salted*," are allowed to dry. A great number of these sheets may be prepared at a time, and kept in a portfolio for use. To render these sensitive, being pinned on the boards, or carefully laid upon folds of white blotting paper, they are to be washed over with the nitrate of silver, applied by means of a camel hair brush, observing the instructions previously given as to the method of moving the brush upon the paper. After the first wash is applied, the paper is to be dried, and then subjected to a second application of the silver solution. The second wash is applied for the purpose of insuring that excess of the nitrate of silver *mixed* with the chloride, of which we have been speaking. Mr. Cooper, with a view to the production of a uniform paper, recommended that it be *soaked* for a considerable length of time in the saline wash, and, after it is dried, that the sheet should be *dipped* into the silver solution; while the operator moved over its surface a glass rod held in two bent pieces of glass, as in fig. 30; the object of which is to remove the small air-bubbles which form on the surface of the paper, and which protect it from the action of the fluid. This process, however well it may answer in preparing paper, is objectionable on the score of economy, as the salts are greatly in excess of the quantities actually required.

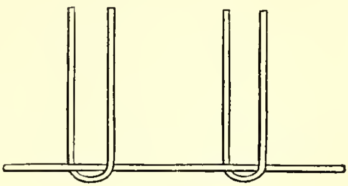

Fig. 30.

It will be found that nearly every variety of paper exposed to the full action of the solar beams will pass through various shades of brown, and become at last of a deep olive colour; it must therefore be understood that the process of darkening is in all cases stopped short of this point. Remembering this, it will be found that very peculiar and often beautiful tints are produced by varying the chloride used, and instead of common salt, employing chloride of barium, or the hydro-chloride of ammonia.

Papers prepared with the chloride of sodium have, however, been more extensively used than any others for positive pictures, owing to the ease with which this material is always to be procured; and for most purposes it answers as well as any other, but it does not produce the most sensitive photographic surface.

The proportions in which this salt has been used are exceedingly various; in general, the solutions have been made too strong; but several chemists have recommended washes that are as much too weak.

For different uses, solutions of various qualities should be employed. It will be found advisable in practice to keep papers of three orders of sensitiveness prepared; the proportions of salt and silver for each being as follows:—

First.—Chloride of sodium, thirty grains to an ounce of water.

Nitrate of silver, one hundred and twenty grains to an ounce of distilled water.

The paper is first soaked in the saline solution, and after being carefully pressed between folds of blotting paper and dried, it is to be washed twice with the solution of silver, drying it by a warm fire between each washing. This paper is very liable to become brown in the dark. Although images may be obtained in the camera obscura on this paper by about half-an-hour's exposure, they are never very distinct, and may be regarded as rather curious than useful.

Second.—A less sensitive paper for copies of engravings—botanical or entomological specimens, should have the following proportions:—

Chloride of sodium, twenty-five grains to an ounce of water.

Nitrate of silver, one hundred grains to an ounce of distilled water.

Third.—A yet more common sensitive paper, for copying lace-work, feathers, patterns of watch-work, &c., may be thus prepared at less expense:—

Chloride of sodium, twenty grains to an ounce of water.

Nitrate of silver, sixty grains to an ounce of distilled water.

This paper keeps very well, and, if carefully prepared, may always be depended upon for darkening equally.

To use these Papers.—The nitrated, the ammonia nitrated, or the muriated papers being prepared, the amateur must now endeavour to obtain photographic pictures.

He therefore takes his copying frame, he turns it face down, and removes the back and cushion; he now places the object which he desires to copy carefully on the glass. If the leaves of plants, the under surfaces of the leaves are placed next the glass, and then the sensitive surface of the prepared sheet of paper is laid upon the leaves, the cushion placed on this, and the back then adjusted, and screwed down. If an engraving is to be copied, the back of the engraving is placed next the glass, so that the face of the print and the sensitive surface of the photographic paper are in contact. Any object being thus arranged, the frame is turned up and exposed to sunshine; the solar rays will thus fall directly upon the exposed parts of the paper and darken it readily, while they pass less freely through the objects which we wish to copy, and hence the paper darkens by degrees proportional to the interruptions offered by the different parts of the interposed medium. After a little time, the exposed surface of the paper will have acquired a fine chocolate or an olive-brown colour, and if we then remove it from the frame, we shall find that we have obtained a *negative* picture of the superposed object, *lights* being represented by *shadows*, and shadows by *lights*. This *negative* picture has now to be *fixed*, or rendered permanent; a process described in the next chapter. When the required permanence is given to the photograph, it becomes to the photographer the *plate* from which any number of impressions can be taken in the manner already described.

CHAPTER IV.

ON FIXING PHOTOGRAPHIC PICTURES.

The power of destroying the susceptibility of a photographic surface, to change by the further action of light, when the picture is completed by its influence, is absolutely necessary for the perfection of the art. Various plans have been suggested for accomplishing this, which have been attended with very different results; few, if any, of the materials used producing the required effect, and, at the same time, leaving the picture unimpaired. The hyposulphite of soda is decidedly superior to any other fixing material; but it will be interesting to name a few other preparations, which may be used with advantage in some instances.

The pictures formed on papers prepared with the nitrate of silver only, may be rendered permanent by washing them in perfectly pure distilled water. The water must be quite free from any chlorides, as these salts convert the nitrate of silver into a chloride, attack the picture with considerable energy, and soon destroy it, by converting the darkened silver itself slowly into a chloride. Herschel remarks—"If the paper be prepared with the simple nitrate, the water must be distilled, since the smallest quantity of any muriatic salt present attacks the picture impressed on such paper with singular energy, and speedily obliterates it, unless very dark. A solution containing only a thousandth part of its weight of common salt suffices to effect this in a few minutes in a picture of considerable strength."

The great point to be aimed at, in fixing any of the sun-pictures is the removal of all that portion of the preparation, whatever it may be, which has not undergone change, without disturbing those parts which have been, in the slightest degree, altered by the chemical radiations. When a picture has been obtained upon paper prepared with the nitrate of silver, or the ammonio-nitrate of silver, the best mode of proceeding is to wash it first with warm rain water, and then with a diluted solution of ammonia: if the ammonia is too strong it dissolves the oxide of silver, which in these processes is formed in the fainter parts of the picture, and thus the more delicate portions are obliterated.

Photographs on the muriated papers are not, however, so easily fixed. Well soaking these in water dissolves out the excess of nitrate of silver, and thus the sensibility is somewhat diminished; indeed, they may be considered as half fixed, and in this state kept for a convenient opportunity of completing the operation.

Chloride of sodium (common salt) was recommended by Mr. Talbot as a fixing material, but it is seldom successful.

It may appear strange to many that the same material which is used to give sensitiveness to the paper should be applied to destroy its sensibility. This is easily explained: In the first instance, it assists in the formation of the chloride of silver; in the second, it dissolves out a large portion of that salt from the paper, chloride of silver being soluble in strong solutions of chloride of sodium. The picture being first washed in water, is to be placed in the brine, and allowed to remain in it for some time; then, being taken out, is to be well washed in water, and slowly dried. After fixing by this process, the white parts of the photograph are often changed to a pale blue—a tint which is not, in some cases, at all unpleasant.

I have in my possession some pictures which have been prepared more than fourteen years, which were then fixed with a strong solution of salt, and subsequently washed with warm water. They became slightly blue in the white portions at once, but otherwise they are very permanent; and they have lost but little of their original character.

The chloride of silver being soluble in ammonia, a solution of that volatile alkali has been recommended for fixing photographs. The ammonia, however, attacks the oxide of silver, which forms the darkened parts in some preparations, and there is great risk of its destroying the picture, or at least of impairing it considerably. The only photographs on which I have used ammonia with complete success are those prepared with the phosphate of silver. Still ammonia affords a ready means of partially fixing a photograph, and thus preserving it until a more convenient period for giving it permanence.

The iodide of silver, which is readily formed by washing the photograph with a solution of the iodide of potassium, is scarcely sensitive to light; and this salt, used in the proportions of five or six grains to four or five ounces of water, answers tolerably well where transfers are not required. It tinges the white lights of the picture of a pale yellow,—a colour which is extremely active in absorbing the chemical rays, and therefore this mode of fixing is quite inapplicable where any copies from the original photograph are required. Bromide of potassium may be employed as a temporary fixing agent, and for this purpose is recommended by Mr. Talbot, and constantly employed by many of the continental travelling photographers; since it will insure the impression from injury until an opportunity presents itself for giving the final permanence to the picture.

Of all the fixing agents, the hyposulphite of soda is decidedly the best. This was first pointed out by Sir John Herschel, who also recommended that it should be used warm in some cases, which was the plan adopted by Mr. Fox Talbot in the improvements of his calotype process.

To use the hyposulphite of soda with effect, there are several precautions necessary. These precautions must be attended to if we desire to give a picture any degree of durability. The fixing process divides itself into several parts, all of which require close attention.

First.—All the free nitrate of silver must be dissolved out of the paper by well washing.

Second.—The photograph being next spread on a plane surface, is to be washed over, on both sides, with a *saturated* solution of the hyposulphite of soda.

Third.—The picture must then be washed, by allowing *a small stream of water to flow over it*, at the same time dabbing it with a piece of soft sponge, until the water passes off perfectly tasteless. This operation should be repeated twice, or in particular cases, even three times.

The hyposulphite of soda has the property of dissolving a large quantity of several of the salts of silver, but particularly of the chloride, with which it combines, forming a triple salt of an exceedingly sweet taste. This salt is liable to spontaneous decomposition, accompanied with separation of silver in the state of sulphide; hence the necessity of freeing the paper, by washing, from every trace of the hyposulphite of silver, the sulphide of silver being of a dirty brown. It might appear that the use of warm water would more effectually cleanse the paper; but it must on no occasion be used in the *first instance*, as it often occasions the immediate formation of the sulphide of silver.

Some operators prefer leaving the picture in a bath of the hyposulphite of soda for some time, and then removing the salt by simple immersion in water, frequently changing it. The advantages of this are said to be, that the surface of the paper is not disturbed by any rubbing action, or by the mechanical action of water flowing over the surface. For example, Mr. Cundell, to whom we are much indebted for improvements in the calotype process, recommends the following mode of manipulation:—

The picture, or as many of them as there may be, is to be soaked in warm water, but not warmer than may be borne by the finger; this water is to be changed once or twice, and the pictures are then to be well drained, and either dried altogether, or pressed in clean and dry blotting-paper, to prepare them to imbibe a solution of the hyposulphite of soda, which may be made by dissolving an ounce of that salt in a quart of water. Having poured a little of the solution into a flat dish, the pictures are to be introduced one by one; daylight will not now injure them: let them soak for two or three minutes, or even longer, if strongly printed, turning and moving them occasionally. The remaining unreduced salts of silver are thus thoroughly removed by soaking in water and pressing in clean blotting-paper alternately; but if time can be allowed, soaking in water alone will have the effect in twelve or twenty-four hours, according to the thickness of the paper. It is essential to the success of the fixing process, that the paper be in the first place thoroughly penetrated by the hyposulphite, and the sensitive matter dissolved; and next, that the hyposulphite compounds be effectually removed. Unless these salts are completely washed out, they induce a destructive change upon the picture; they become opaque in the tissue of the paper, and unfit it for the operation of being copied. The objections to the soaking process are, that although we may, by frequently changing the water, appear to dissolve out the hyposulphite of silver, yet since the last water employed is to be used for the purpose of removing some adhering salt from the paper, and since the paper is taken from that water and dried, it must still contain a small—it may be infinitely small—portion of the salt. However minute may be the quantity of the hyposulphite which remains in the paper, it will go on slowly but steadily working upon the photograph, and under the combined influences of light and air, eventually destroy it.

Much has been said and written about improving the *tone* of the picture by the use of *old* hyposulphite of soda, and of the hyposulphite in which chloride of silver has been dissolved. My own experience, which is corroborated by that of many of the most successful photographic artists in England and on the continent, convinces me, that in aiming at peculiarity of tint by these methods, the permanency of the photograph is injured. I have pictures, produced by different artists, fixed after this method, and scarcely one of them remains free from change.

The object is to remove all the chloride or iodide of silver; and to secure this, as much hyposulphite of soda should be *uncombined* with chloride or iodide of silver, in the solution as possible.

It will now be understood that the hyposulphite of silver being formed, it has to be dissolved out of the paper, the fibres of which hold it with a strong capillary force. It is only by very long continued soaking, and in a succession of clean waters, that all can be removed,—but the slight mechanical aid afforded by dabbing the surface of the paper with a soft sponge well filled with water, and allowing the water to stream off the paper, greatly accelerates the removal of the salt; and when the paper ceases to *taste sweet*, we may depend upon the permanence of the photograph. Much has been said and written upon the permanence of photographic pictures, and much annoyance has been felt by the purchasers of very fine photographic pictures, upon seeing them fade out within a few months. *Photographs need not of necessity fade*,—where they do fade, blame rests with the photographer, who has not bestowed the required care in giving them permanence. If the *streaming process*, instead of the *soaking one* is adopted, and if the pictures are *toned* with gold instead of sulphur, photographs are as permanent as water colour drawings.

CHAPTER V.

THE CALOTYPE.

EARLY in 1840, photographic pictures on paper were handed about in the scientific circles of London and Paris, which were a great advance upon anything which had been previously done. These were the result of a newly discovered process by Mr. Henry Fox Talbot, and called by him THE CALOTYPE.

Mr. Talbot's description of his process is as follows:—

Take a sheet of the best writing paper, having a smooth surface, and a close and even texture. The water-mark, if any, should be cut off, lest it should injure the appearance of the picture. Dissolve 100 grains of crystallized nitrate of silver in six ounces of distilled water. Wash the paper with this solution with a soft brush, on one side, and put a mark on that side, whereby to know it again. Dry the paper cautiously at a distance from the fire, or else let it dry spontaneously in a dark room. When dry, or nearly so, dip it into a solution of iodide of potassium, containing 500 grains of that salt dissolved in one pint of water, and let it stay two or three minutes in the solution. Then dip the paper into a vessel of water, dry it lightly with blotting-paper, and finish drying it at a fire, which will not injure it even if held pretty near; or else it may be left to dry spontaneously. All this is best done in the evening by candle-light: the paper, so far prepared, is called *iodized paper*, because it has a uniform pale yellow coating of iodide of silver. It is scarcely sensitive to light, but nevertheless it ought to be kept in a portfolio or drawer until wanted for use. It may be kept for any length of time without spoiling or undergoing any change, if protected from sunshine. When the paper is required for use, take a sheet of it, and wash it with a liquid prepared in the following manner:—

Dissolve 100 grains of crystallized nitrate of silver in two ounces of distilled water; add to this solution one-sixth of its volume of strong acetic acid. Let this be called mixture A.

Make a saturated solution of crystallized gallic acid in cold distilled water. The quantity dissolved is very small. Call this solution B.

Mix together the liquids A and B in equal volumes, but only a small quantity of them at a time, because the mixture does not keep long without spoiling. This mixture Mr. Talbot calls the *gallo-nitrate of silver*. This solution must be washed over the iodized paper on the side marked, and being allowed to remain upon it for half-a-minute, it must be dipped into water, and then lightly dried with blotting-paper. This operation in particular requires the total exclusion of daylight; and although the paper thus prepared has been found to keep for two or three months, it is advisable to use it within a few hours, as it is often rendered useless by spontaneous change in the dark.

Paper thus prepared is exquisitely sensitive to light; an exposure of less than a second to diffused daylight being quite sufficient to set up the process of change. If a piece of this paper is partly covered, and the other exposed to daylight for the *briefest possible period of time*, a very decided impression will be made. This impression is latent and invisible. If, however, the paper be placed aside in the dark, it will gradually *develop itself;* or it may be brought out immediately by being washed over with the gallo-nitrate of silver, and held at a short distance from the fire, by which the exposed portions become brown, the covered parts remaining of their original colour. The pictures being thus procured, are to be fixed by washing in clean water, and lightly drying between blotting-paper, after which they are to be washed over with a solution of bromide of potassium, containing 100 grains of that salt, dissolved in eight or ten ounces of water, after a minute or two it is again dipped into water, and then finally dried.

Such was the description given by Mr. Fox Talbot in the specification of his patent in 1841.

This photographer, during 1852, made the country a gift of his patents, reserving only the right of a patentee over that portion which includes the practice of taking portraits for sale. (See the letters in the appendix.) More recently still it was decided in a court of law, that the patentee's claim to this process as specified was good, but that it did not extend to the collodion process, which he thought to claim; thus, virtually, the art of photography was freed from all the annoyances of patent restrictions.

The first important improvement on the calotype was due to Mr. Cundell, who published the following process in the *Philosophical Magazine* for May, 1844:—

1. To produce a calotype picture, there are five distinct processes, all of which, except the third, must be performed by candle-light: they are all very simple, but at the same time, they all require care and caution. The first, and not the least important, is—

2. **The Iodizing of the Paper.**—Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and of not less than medium thickness. The best I have met with is a fine satin post paper, made by "R. Turner, Chafford Mill." Having selected a half-sheet without flaw or water-mark, and free from even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver, by the mutual decomposition of two salts, nitrate of silver and iodide of potassium. There is a considerable latitude in the degree of dilution in which these salts may be used, and also in the manner and order of their application; but as the thickness and regularity of the coating depend upon the solution of nitrate of silver, and upon the manner in which it is applied, I think it ought by all means to be applied first, before the surface of the paper is disturbed. I use a solution of the strength of seventeen grains to the ounce of distilled water.

3. The paper may be pinned by its two upper corners to a clean dry board a little larger than itself; and, holding this nearly upright in the left hand, and commencing at the top, apply a wash of the nitrate of silver *thoroughly, evenly, and smoothly*, with a large soft brush, taking care that every part of the surface be thoroughly wetted, and that nothing remain unabsorbed in the nature of free or running solution. Let the paper now hang loose from the board into the air to dry, and by using several boards time will be saved.

4. The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium: the iodine goes to the silver, and the nitric acid to the potash.

5. Take a solution of the iodide of potassium of the strength of 400 grains to a pint of water, to which it is an improvement, analogous to that made by M. Claudet in the daguerreotype, to add 100 grains of common salt. He found that the chloridated iodide of silver is infinitely more sensitive than the simple iodide; and by this addition of common salt, a similar, though a less remarkable, modification is obtained of the sensitive compound. Pour the solution into a shallow flat-bottomed dish, sufficiently large to admit the paper, and let the bottom of the vessel be covered to the depth of an eighth of an inch. The prepared side of the paper, having been previously marked, is to be brought in contact with the surface of the solution, and, as it is desirable to keep the other side clean and dry, it will be found convenient, before putting it in the iodine, to fold upwards a narrow margin along the two opposite edges. Holding by the upturned margin,

the paper is to be gently drawn along the surface of the liquid until its lower face be thoroughly wetted on every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid: it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound, just formed upon the paper, upon further exposure, would gradually be redissolved. The paper is therefore to be removed, and, after dripping, it may be placed upon any clean surface with the wet side uppermost until about half dry, by which time the iodine solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver, which it is quite indispensable it should do, as the smallest portion of undecomposed nitrate of silver would become a black stain in a subsequent part of the process.

6. The paper is now covered with a coating of the iodide of silver; but it is also covered, and indeed saturated, with saltpetre and the iodide of potassium, both of which it is indispensable should be completely removed. To effect the removal of these salts, it is by no means sufficient to "dip the paper in water;" neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off. But the margin of the paper being still upturned, and the unprepared side of it kept dry, it will be found that by setting it afloat on a dish of clean water, and allowing it to remain for five or ten minutes, drawing it gently now and then along the surface to assist in removing the soluble salts, these will separate by their own gravity, and (the iodide of silver being insoluble in water) nothing will remain upon the paper but a beautifully perfect coating of the kind required.

7. The paper is now to be dried; but, while wet, do not on any account touch or disturb the prepared surface with blotting-paper, or with anything else. Let it merely be suspended in the air; and, in the absence of a better expedient, it may be pinned across a string by one of its corners. When dry, it may be smoothed by pressure. It is now "iodized" and ready for use, and in this state it will keep for any length of time if protected from the light. The second process is that of exciting or

8. **Preparing the Paper for the Camera.**—For this purpose are required the two solutions described by Mr. Talbot; namely, a saturated solution of crystallized gallic acid in cold distilled water, and a solution of the nitrate of silver of the strength of fifty grains to the ounce of distilled water, to which is added one-sixth part of its volume of glacial acetic acid. For many purposes these solutions are unnecessarily strong, and, unless

skilfully handled, they are apt to stain or brown the paper: where extreme sensitiveness, therefore, is not required, they may with advantage be diluted to half the strength, in which state they are more manageable and nearly as effective. The gallic acid solution will not keep for more than a few days, and only a small quantity, therefore, should be prepared at a time. When these solutions are about to be applied to the iodized paper, they are to be mixed together, in equal volumes, by means of a graduated drachm tube. This mixture is called "the gallo-nitrate of silver." As it speedily changes, and will not keep for more than a few minutes, it must be used without delay, and it ought not to be prepared until the operator is quite ready to apply it.

9. The application of this "gallo-nitrate" to the paper is a matter of some nicety. It will be found best to apply it in the following manner:—Pour out the solution upon a clean slab of plate-glass, diffusing it over the surface to a size corresponding to that of the paper. Holding the paper by a narrow upturned margin, the sensitive side is to be applied to the liquid upon the slab, and brought in contact with it by passing the fingers gently over the back of the paper, which must not be touched with the solution.

10. As soon as the paper is *wetted* with the gallo-nitrate, it ought instantly to be removed into a dish of water; five or ten seconds at the most is as long as it is safe at this stage to leave the paper to be acted upon by the gallo-nitrate; in that space of time it absorbs sufficient to render it exquisitely sensitive. The excess of gallo-nitrate must immediately be washed off by drawing the paper gently several times under the surface of water, which must be perfectly clean; and being thus washed, it is finished by drawing it through fresh water, two or three times. It is now to be dried in the dark, in the manner described in § 7; and, when surface-dry, it may either be placed, while still damp, in the camera, or in a portfolio among blotting-paper, for use. If properly prepared, it will keep perfectly well for four-and-twenty hours at least, preserving all its whiteness and sensibility.

11. The light of a single candle will not injure the paper at a moderate distance; but the less the paper, or the exciting solution, is exposed, even to a feeble candle-light, the better. Common river or spring water answers perfectly to *wash* the paper, distilled water being required only for the silver solutions.

Stains of "gallo-nitrate," while recent, may be removed from the fingers by a little strong ammonia, or by the cyanide of potassium.

The third process is that of

12. **The Exposure in the Camera Obscura**, for which, as the operator must be guided by his own judgment, few directions can be given, and few are required. He must choose or design his own subject; he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to three or four minutes. The subject ought, if possible, to have a strong and decided effect; but extreme lights, or light-coloured bodies, in masses, are by all means to be avoided. When the paper is taken from the camera, very little trace, or more commonly no trace whatever, of a picture is visible until it has been subjected to the fourth process, which is

13. **The Bringing-out of the Picture**; this is effected by again applying the "gallo-nitrate" in the manner directed in § 9. As soon as the paper is wetted all over, unless the picture appear immediately, it is to be exposed to the radiant heat from an iron or any similar body, held within an inch or two by an assistant. It ought to be held vertically, as well as the paper; and the latter ought to be moved, so as to prevent any one part of it becoming dry before the rest.

As soon as the picture is sufficiently brought out, wash it immediately in clean water to remove the gallo-nitrate, as directed in § 10; it may then be placed in a dish by itself, *under* water, until you are ready to fix it. The most perfect pictures are those which "come out" before any part of the paper becomes dry, which they will do if sufficiently impressed in the camera. If the paper be allowed to dry before washing off the gallo-nitrate, the lights sink and become opaque; and if exposed in the dry state to heat, the paper will darken; the drying, therefore, ought to be *retarded*, by wetting the back of the paper, or the picture may be brought out by the vapour from hot water, or, what is better, a horizontal jet of steam. The fifth and last process is

14. **The Fixing of the Picture**, which is accomplished by removing the sensitive matter from the paper as already described.

15. **The Printing Process.**—The picture being thus fixed, it has merely to be dried and smoothed, when it will undergo no further change. It is, however, a *negative* picture, and if it have cost some trouble to produce it, that trouble ought not to be grudged, considering that you are now possessed of a matrix which is capable of yielding a vast number of beautiful impressions.

The manner of obtaining these impressions has been already described, but there are so many different modes of proceeding, that it may not be out of place to notice briefly the best processes recommended. Photography is indebted to Dr. Alfred Taylor for the following. His solution is made by dissolving one part of nitrate of silver in twelve of distilled water, and gradually adding strong liquid ammonia until the precipitate at first produced is at length *just* redissolved.

Some paper is to be met with, containing traces of bleaching chlorides, which does not require any previous preparation; but in general it will be found necessary to prepare the paper by slightly impregnating it with a minute quantity of common salt. This may be done by dipping it in a solution in which the salt can barely be tasted, or of the strength of from thirty to forty grains to a pint of water. The paper, after being pressed in clean blotting-paper, has merely to be dried and smoothed, when it will be fit for use.

The ammonio-nitrate of silver is applied to the paper in the manner described in § 3; and, when perfectly dry, the negative picture to be copied is to be applied to it, with its face in contact with the sensitive side. The back of the negative picture being uppermost, they are to be pressed into close contact by means of a plate of glass; and thus secured, they are to be exposed to the light of the sun and sky. The exposed parts of the sensitive paper will speedily change to lilac, slate-blue, deepening towards black; and the light, gradually penetrating through the semi-transparent negative picture, will imprint upon the sensitive paper beneath a *positive* impression. The negative picture, or matrix, being slightly tacked to the sensitive paper by two mere particles of wafer, the progress of the operation may from time to time be observed, and stopped at the moment when the picture is finished.

It ought then, as soon as possible, to be soaked in warm water, and fixed in the manner described.

In these pictures there is a curious and beautiful variety in the tints of colour they will occasionally assume, varying from a rich golden orange to purple and black. This effect depends in a great degree upon the paper itself; but it is modified considerably by the strength of the hyposulphite, the length of the time exposed to it, by the capacity of the paper to imbibe it, and partly, perhaps, by the nature of the light. Warm sepia-coloured pictures may generally be obtained by drying the paper, by pressure, and making it imbibe the hyposulphite supplied in liberal quantity, carefully removing it by subsequent washing.

The paper of "I. Whatman, Turkey Mill," seems to give pictures of the finest colour, and, upon the whole, to answer best for the purpose of positive photographs.

If the chemical agents employed be pure, the operator, who keeps in view the *intention* of each separate process, and either adopting the manipulation recommended, or improving upon it from his own resources, may rely with confidence upon a satisfactory result.

This calotype paper is so exceedingly sensitive to the influence of light, that very beautiful photographic copies of lace, feathers, leaves, and such like articles, may be made by the light of a common coal-gas flame, or an Argand lamp. The mode of proceeding is precisely that described for obtaining the ordinary photographic drawings by daylight, only substituting the calotype paper, which should be damp, for the common photographic.

When exposing the prepared paper to the light, it should be held about four or five inches from the flame, and the time required will be about three minutes.

But little remains to be added to this very clear and satisfactory description of the calotype process,—to which, indeed, is mainly due the perfection to which it has arrived both at home and abroad.

There are, however, a few modifications which must be noticed, as tending to simplify the details in some cases, and to improve the general effects in others. In the main, however, it will be found that Mr. Cundell's process of manipulation is as good as any that can be adopted: and that gentleman certainly merits the thanks of all photographers.

Many modifications of Mr. Talbot's mode of manipulating have been introduced with very variable advantages. I have, however, found that nearly every variety of paper requires some peculiar method to excite it to its maximum degree of sensibility. A few of the published methods will be noticed in the next chapter as, under different circumstances, they may prove useful.

A good negative picture being obtained, it is important to give it as much transparency as possible, so that the positive copy from it may possess sharpness of outline, and graduated tones. This is best effected by waxing the negative. To do this, place the negative photograph on a metal plate, which has been heated by some convenient method, then rub pure white wax on the face of it until the paper is saturated, then remove the excess of wax by means of bibulous paper.

CHAPTER VI.

MODIFIED FORMS OF THE CALOTYPE PROCESS.

Various methods have been, from time to time, suggested for increasing the sensibility of the calotype paper, and facilitating its use. A few of these must be named.

Mr. Robert Bingham recommends the following process:—Apply to paper a solution of nitrate of silver, containing 100 grains of that salt to one ounce of distilled water; when nearly, but not quite dry, dip it into a solution of iodide of potassium, of the strength of twenty-five grains of the salt to one ounce of distilled water, drain it, wash it, and then allow it to dry. Now brush it over with aceto-nitrate of silver, made by dissolving fifty grains of nitrate of silver in one ounce of distilled water, to which is added one-sixth its volume of strong acetic acid. Dry it with bibulous paper, and it is now ready for receiving the image. When the impression has been received, it must be washed with a saturated solution of gallic acid, and exposed to a steam heat, a jet of steam from the spout of a tea-kettle, or any convenient vessel. The image will be gradually brought out, and may be fixed with hyposulphite of soda. It will be observed that in this process the solutions of nitrate of silver and of gallic acid are not mixed before application to the paper, as in Mr. Talbot's process.

Mr. Channing, of Boston, very much simplified the calotype process. He directs that the paper should be first washed over with sixty grains of crystallized nitrate of silver, dissolved in one ounce of distilled water, and when dry, with a solution of ten grains of the iodide of potassium in one ounce of water: it is then to be washed with water, and dried between folds of blotting-paper: the sensibility of the paper is correctly said to be much improved by combining a little chloride of sodium with the iodide of potassium: five grains of the latter salt, and rather less than this of the former, in an ounce of water, may be employed advantageously.

To use this paper of Mr. Channing's, where time is an object, it is necessary to wash it immediately before it is placed in the camera obscura, with a weak solution of nitrate of silver, to which a drop or two only of gallic acid has been added. The picture is subsequently developed by the gallo-nitrate of silver, as already described.

Blanquart Everard, Sagnez, and some others, have recommended that in the preparation of the highly sensitive photographic papers no brushes should be employed. They pour the solutions upon a perfectly flat piece of glass, and the paper is then carefully drawn over it, and if necessary, pressed closer by another plate of glass. This is, however, an unnecessary refinement; if ordinary care is taken with the processes already described, nothing can be more satisfactory than the result.

A plan of iodizing paper has been proposed by Mr. Jordan, which offers many advantages, and is consequently frequently adopted. Iodide of silver is precipitated from the solution of the nitrate by iodide of potassium, and this precipitate being slightly washed, is redissolved in a strong solution of the latter salt. This solution is applied to the paper, and the paper allowed to dry; after this it is placed face downwards upon some clean water; the iodide of potassium is removed by this, and a pure iodide of silver left on the paper.

If the paper carefully and properly iodized is washed with a very dilute solution of the gallo-nitrate of silver,—that is to say, a solution composed of ten grains of nitrate of silver to one fluid ounce of distilled water is added to another ounce of distilled water with ten drops of a concentrated solution of gallic acid, it will keep for three weeks or a month. It may be used dry in the camera, and afterwards developed with the gallo-nitrate in the usual manner. It will, however, require an exposure in the camera of from ten to twenty minutes, and is, therefore, only useful for still objects; but for buildings, landscapes, foliage, and the like, nothing can be more useful.

Le Gray recommends as a highly sensitive paper for portraits the following:—

Distilled water, ...	6,200 grains.
Iodide of potassium, ...	300 ,,
Cyanide of potassium, ...	30 ,,
Fluoride of potassium, . . .	1 ,,

Papers are washed with this, and then with his strong solution of aceto-nitrate of silver, which is described in the section devoted to the wax paper process.

M. A. Martin, who is aided by the Imperial Academy of Sciences of Vienna in his endeavours to improve the photographic processes, and render them available to the purposes of art, has published the following as the best proportions in which the solutions should be made, and the order of their application.

For the negative picture—

First.	Iodide of potassium, . . .	½ oz.
	Distilled water, . . .	10 fluid oz.
	Concentrated solution of cyanide of potassium, . . .	7 drops.
Second.	Nitrate of silver, . . .	7 drachms.
	Distilled water, . . .	10 fluid oz.
	Strong acetic acid, . . .	2 drachms.
Third.	A concentrated solution of gallic acid.	
Fourth.	Good spirits of wine.	
Fifth.	Hyposulphite of soda, . . .	1 oz.
	Distilled water, . . .	10 fluid oz.

For the positive pictures—

First.	Chloride of sodium, ...	168 grains.
	Distilled water, ...	10 oz.
Second.	Nitrate of silver, ...	1 oz.
	Distilled water, ...	10 oz.
Third.	Hyposulphite of soda, . . .	1 oz.
	Distilled water, ...	40 oz.

Nitrate of silver thirty grains, dissolved in half an ounce of distilled water, to be poured into the solution, in a small stream, while it is constantly stirred with a glass rod.

M. Martin particularly recommends the application of the iodine salt first to the paper, drying this, then applying the argentine solution, and drying rapidly. I have urged the necessity of this on several occasions; the advantages are, that the iodide of silver is left on the very surface of the paper ready for the influence of the slightest chemical radiation.

The productions of M. Flacheron excited much interest, and the processes by which these were obtained in the Eternal City were eagerly sought for by photographic amateurs. Mr. Thomas published the calotype process by which the photographers of Rome produce their best effects; and as being useful in hot climates, a sufficient portion of that communication is retained in these pages.

"1*st.* Select old and thin English paper—I prefer Whatman's; cut it in such a manner that the sheet shall be the sixteenth of an inch smaller than the glass of the paper-holder on every side, and leave two ends at diagonal corners to the sheet by which to handle it.

"2*d*. Prepare the following solution:—

"Saturated solution of iodide of potassium 2½ fluid drachms: pure iodide nine grains: dissolve.

"Then add, distilled water 11½ ounces, iodide of potassium four drachms, bromide of potassium ten grains, and mix. Now, filter this solution into a shallow porcelain vessel somewhat larger than the sheet of paper to be prepared. Take a piece by the two diagonal ends, and gently place the end of the marked side nearest to you, upon the surface of the bath; then carefully incline the surface of the sheet to the liquid, and allow it to rest two minutes; if French paper, one minute, or until the back of the paper (not wetted) becomes tinted uniformly by the action of the dark-coloured solution. Raise it up by means of the two ends occasionally, in order to chase away any air-bubbles, which would be indicated by white spots on the back, showing that the solution in these parts has not been absorbed. Hold the paper by one of the ends for a minute or so, in order that the superfluous moisture may run off, then hang up to dry, by pinning the one end to a string run across a room, and let the excess drop off at the diagonal corner. When dry the paper is ready for use, and quite tinted with iodine on both sides. It will keep any length of time, and is much improved by age.

"3*d*. I will presume that four sheets are to be excited for the camera, and that the operator has two double paper-holders, made without a wooden partition, the interior capacity of which is sufficiently large to admit of three glasses, all moveable. The third, as will be seen, is to prevent the two pieces of excited paper coming in contact with each other.

"Prepare the following solution:—

"Take nitrate of silver 2½ drachms; acetic acid 4½ drachms; distilled water 3½ ounces: mix and dissolve.

"Now take four of the glasses of the paper-holders perfectly clean, and place each upon a piece of common blotting-paper to absorb any little excess of liquid. Pour about 1½ drachm, or rather more of the solution just prepared, into a small glass funnel, in which a filter of white bibulous paper has been placed, and let the solution filter drop by drop upon glass No. 1, until about 1½ drachm has been filtered in detached drops, regularly placed upon its surface: then, with a slip of paper, cause the liquid to be diffused over the whole surface of the glass. Take a piece of prepared paper, and place it marked, side downwards, upon a glass just prepared, beginning at the end nearest you, and thus chasing out the air. Draw it up once or twice by its two diagonal corners; allow it to rest, and prepare glass No. 2 in a similar manner. Now look at glass No. 1, and it will be perceived that the violet tint of the paper has become mottled with patches of white, which gradually spread, and in a few seconds the paper resumes its original whiteness, which is an indication that it is ready for the camera. It will be found to adhere firmly to the glass. Do not remove it; but hold the glass up to allow the excess of fluid to run off at one corner. It must not be touched with blotting-paper, but replaced flat on the table. Serve Nos. 2, 3, and 4, in like manner. Take four pieces of common white paper, not too much sized, free from iron spots, and cut a trifle smaller than the prepared sheet; soak them in distilled water; draw out one piece, hold it up by the fingers to drain off superfluous moisture, and place it gently upon the back of the prepared paper. With another piece of glass kept for the purpose, having the edge rounded, and large enough to act uniformly upon the paper, scrape off gently the excess of liquid, beginning at the top of the sheet, and removing with the rounded edge of the scraper the liquid to one of the corners. Repeat this operation twice. Both the excited and superimposed paper are fixed to the glass. Two glasses and papers being thus prepared, take the clean glass No. 5, and place upon No. 1: press gently: the moist paper will cause it to adhere. Take up the two glasses thus affixed and place them upon glass No. 2, in such a manner that the supernumerary glass No. 5 shall be in the centre. The whole will form a compact body, and having polished the surfaces, and wiped the edges, may at once be put in the paper-holders. * * *

"4*th.* With a Ross's, Chevalier's, or Lerebours' single lens, three inches diameter, and half an inch diaphragm, the object to be copied, well lighted by the sun, the paper will require from four to six minutes' exposure.

"5*th.* Take out the three glasses, which will still firmly adhere, separate them gently, and remove the piece of moistened paper, which must not be used again. Now lift up the prepared paper by one corner to the extent of half the glass, and pour into the centre about one drachm of a saturated solution of gallic acid, which will immediately diffuse itself. Raise also the other corner to facilitate its extension; and serve the others in like manner. The image takes generally from ten to twenty minutes to develop. Hold up the glass to a candle to watch its intensity. When sufficiently developed remove the negative from the glass. Wash it in two or three waters for a few hours, dry with blotting-paper, and immerse each separately for ten minutes in a bath of bromide of potassium in solution: then wash and dry.

"The iodide may be removed by means of hyposulphite of soda in the usual way, twelve months afterwards, or when convenient." "If," says Mr. Thomas, "the process has been carefully conducted, four beautiful negatives must be the result. I was ten days working incessantly at Pompeii, and scarcely ever knew what a failure was."

Mr. Muller, a gentleman who has been practising photography with great success at Patna, in the East Indies, has communicated his process to me, which is as follows:—

A solution of hydriodate of iron is made in the proportions of eight or ten grains of iodide of iron to one ounce of water; this solution is prepared in the ordinary way, with iodine, iron turnings, and water. The ordinary paper employed in photography is washed on one side with a solution of nitrate of lead (fifteen grains of the salt to one ounce of water); when dry, this paper is iodized either by immersing it completely in the solution of the hydriodate of iron, or by floating the leaded surface on the solution. It is removed after a minute or two, and lightly dried with blotting-paper. The paper now contains iodide of lead and protonitrate of iron: while still moist it is rendered sensitive by a solution of nitrate of silver (100 grains to the ounce of water) and placed in the camera. After the ordinary exposure it may be removed to a dark room; if the image is not already developed, it will be found speedily to appear in great sharpness *without any further application.* It may then be fixed with the hyposulphite of soda in the usual manner.

In December, 1852, Sir John Herschel communicated to the pages of the *Athenæum* a letter from his brother-in-law, Mr. Stewart, a resident at Pau, in the Pyrenees. In this he states, that, at the suggestion of Professor Regnault, he was induced to adopt a process of manipulation which gave some charming results, and which he thus describes:—

"The following observations are confined to negative paper processes divisible into two—the *wet* and the *dry*. The solutions I employ for both these processes are identical, and are as follows:—

"Solution of iodide of potassium, of the strength of five parts of iodide to 100 of pure water.

"Solution of aceto-nitrate of silver, in the following proportions: —fifteen parts of nitrate of silver, twenty parts of glacial acetic acid, and 150 parts of distilled water.

"Solution of gallic acid for developing—a saturated solution.

"Solution of hyposulphite of soda, of the strength of one part of the salt to from six to eight parts of water.

"For both the wet and dry process I iodize my paper as follows:—In a tray containing the above solution I plunge, one by one, as many sheets of paper (twenty, thirty, fifty, &c.) as are likely to be required for some time. This is done in two or three minutes. I then roll up loosely the whole bundle of sheets while in the bath; and picking up the roll by the ends, drop it into a cylindrical glass vessel with a foot to it; and pour the solution therein (enough to cover the roll completely); in case it should float up above the surface of the solution, a little piece of glass may be pushed down to rest across the roll of paper and prevent its rising. The vessel with the roll of paper is placed under the receiver of an air-pump and the air exhausted; this is accomplished in a very few minutes, and the paper may be left five or six minutes in the vacuum. Should the glass be too high (the paper being in large sheets) to be inserted under the pneumatic pump-receiver, a stiff lid lined with India-rubber, with a valve in the centre communicating by a tube with a common direct-action air-pump, may be employed with equal success. After the paper is thus soaked *in vacuo* it is removed, and the roll dropped back into the tray with the solution, and thus sheet by sheet picked off and hung up to dry, when, as with all other iodized paper, it will keep for an indefinite time.

"I cannot say that I fully understand the rationale of the action of the air-pump, but several valuable advantages are obtained by its use:—1st, The paper is thoroughly iodized, and with an equality throughout that no amount of soaking procures, for no two sheets of paper are alike, or even one perfect throughout in texture, and air-bulbs are impossible. 2d, The operation is accomplished in a quarter of an hour, which generally occupies one, two, or more hours. 3d, To this do I chiefly attribute the fact that my paper is never solarized even in the brightest sun; and that it will bear whatever amount of exposure is necessary for the deepest and most impenetrable shadows in the view without injury to the bright light."

"**Wet Process.**—To begin with the *wet* process. Having prepared the above solution of aceto-nitrate of silver, float a sheet of the iodized paper upon the surface of this sensitive bath, leaving it there for about ten minutes. During this interval, having placed the glass or slate of your slider quite level, dip a sheet of *thick* clean white printing (unsized) paper in water, and lay it on the glass or slate as a wet lining to receive the sensitive sheet. An expert manipulator may then, removing the sensitive sheet from the bath, extend its sensitive side uppermost on this wet paper lining, without allowing any air-bubbles to intervene; but it is difficult: and a very simple and most effectual mode of avoiding air-globules, particularly in handling very large sheets, is as follows:—Pour a thin layer of water (just sufficient not to flow over the sides) upon the lining paper after you have extended it on your glass or slate, and then lay down your sensitive paper gently, and by degrees, and floating, as it were, on this layer of water, and when extended take the glass and papers between the finger and thumb by an upper corner, to prevent their slipping; tilt it gently to allow the interposed water to flow off by the bottom, which will leave the two sheets adhering closely and perfectly, without the slightest chance of air-bubbles; it may then be left for a minute or two standing upright in the same position, to allow every drop of water to escape; so that when laid flat again, or placed in the slider, none may return back again and stain the paper. Of course the sensitive side of the sheet is thus left exposed to the uninterrupted action of the lens, no protecting plate of glass being interposed; and even in this dry and warm climate, I find the humidity and the attendant sensitiveness preserved for a couple of hours.

"**Dry Process.**—In preparing sheets for use when *dry* for travelling, &c., I have discarded the use of previously waxed paper, thus getting rid of a troublesome operation, and proceed as follows:—Taking a sheet of my iodized paper, in place of floating it (as for the wet process) on the sensitive bath, I plunge it fairly into the bath, where it is left to soak for five or six minutes; then removing it, wash it for about twenty minutes in a bath, or even two of distilled water, to remove the excess of nitrate of silver, and then hang it up to dry (in lieu of drying it with blotting-paper). Paper thus prepared possesses a greater degree of sensitiveness than waxed paper, and preserves its sensitiveness, not so long as waxed paper, but sufficiently long for all practical purposes, say thirty hours, and even more. The English manufactured paper is far superior for this purpose to the French. To develop these views a few drops of nitrate of silver are required in the gallic acid bath, and they are finally fixed and waxed as usual."

It will be apparent to the careful reader, that the processes given, are in all essential particulars the same. To a few simple alterations in the manipulatory details are due the variations in sensibility, and in the general effect of the resulting picture.

The main principles are:—

1*st.* To iodize the paper—that is, to secure a uniform coating of iodide of silver over every part of the surface of the paper, and an entire absence of either the alkaline salt or the metallic nitrate.

2*d.* To have an excess of nitrate of silver spread over the iodide a short time previously to using the paper; and if a high degree of sensibility is required, the combination of such an organic decomposing agent as gallic acid.

In all the photographs obtained by this process, the impressions from green leaves are very imperfect. This is only to be obviated by adopting the advice of Herschel, and substituting the bromide for the iodide of silver. The following remarks are so much to the point, that I have transferred them from the *Journal of the Photographic Society*:—

"I have read," says Sir J. F. W. Herschel, "with considerable interest the remarks of Sir W. J. Newton, *On Photography in its Artistic view*, &c., communicated to the Photographic Society, and by them printed in the Journal of their Society (No. 1). These remarks are in perfect consonance with my own impressions as to the absence, in the very best photographic *landscape* I have seen, of a true artistic representation of the relative intensities of light and shade, the consequence of which is usually a most painful want of keeping;—a struggle to come forward of parts which nature suppresses, and a want of *working out*, in features which, to the eye, are palpably distinct.

"Sir W. J. Newton strikes with the true eye of the painter on the more prominent evil of the whole case; he says, 'Wonderful as the powers of the camera are, we have not yet attained that degree of perfection as to represent faithfully the effect of *colours*, and consequently of *light and shade*. For instance, a bright red or yellow, which would act as a *light* in nature, is always represented as a *dark* in the camera, and the same with green. Blue, on the contrary, is always lighter. Hence the impossibility of representing the true effect of nature, or of a picture, by means of photography.

"No one can have viewed the exquisite pictures of M. Regnault or Mr. Stewart, without feeling that *vegetation* is unduly black and wanting in artistic production. No one who has studied colours, not as an artist, but as a photologist, can for a moment be ignorant of its cause. The red and yellow rays, and *especially the former, which form so large a portion of vegetable greens*, are suppressed. They affect not the materials at present used in the photographic art in its highest development.

"One word suffices for the key of the difficulty—IODINE. It is to the practically exclusive use of this element that the whole evil complained of (most justly) is attributable. I have shown (see my papers, *Phil. Trans.*, 1840, 1842, Articles 129, 217, and 'On the Action of the Rays of the Solar Spectrum on the Daguerreotype plate,' *Lond., Ed., and Dubl. Phil. Journal*, 1843, Art. xix.) that iodized silver is insensible, or nearly so, to the red and orange rays—that its range of sensibility begins, with astonishing abruptness, beyond the medium yellow and within the blue region—is powerful at the indigo, and extends far into rays which have absolutely no effect in producing vision. No wonder then that iodine produces pictures unsatisfactory to the artistic eye. Iodine then must be thrown overboard or limited in its use, *coute qui coute* (and the sacrifice is a formidable one), if photography shall ever satisfy the desires of the artists.

"What then are we to have recourse to? BROMINE. A new photography has to be created, of which bromine is the basis. This I have proved in my experiments on this substance (*Phil. Trans.*, 1840, Art. 77; also Art. xix. *Lond.*, *Ed.*, *&c.*, *Journal*, above cited). The action of every *luminous* ray, so far as can be traced, is equable throughout the spectrum; but the rays beyond the luminous ones act powerfully, and these MUST be eliminated. A glass screen, with a very slight yellow tinge applied close to the focal picture, or, still better, a glass cell, with optically true surfaces, containing a weak solution of sulphate of quinine, according to the recent results of Prof. Stokes, will effectually cut off these, and reduce the action of the rays within the limits which art recognizes. I believe M. Becquerel has used the latter liquid with a similar view. I will only add, that it were much to be wished that artists would study *the spectrum* and its habitudes in relation to their pigments."

Improvements in Calotype by Mr. Talbot.—These improvements consist of the following particulars, constituting that gentleman's second patent claim.

1. Removing the yellowish tint which is occasioned by the iodide of silver, from the paper, by plunging it into a hot bath of hyposulphite of soda dissolved in ten times its weight of water, and heated nearly to the boiling point. The picture should remain in the bath about ten minutes, and be then washed in warm water and dried.

Although this has been included by Mr. Talbot in his specification, he had clearly no claim to it, since, in February, 1840, Sir John Herschel published, in his Memoir "On the Chemical Action of the Rays of the Solar Spectrum," a process of fixing with the *hot* hyposulphite of soda.

After undergoing the operation of fixing, the picture is placed upon a hot iron, and wax melted into the pores of the paper to increase its transparency.

2. The calotype paper is rendered more sensitive by placing a warm iron behind in the camera whilst the light is acting upon it.

3. The preparation of *io-gallic paper*, which is simply washing

a sheet of iodized paper with gallic acid. In this state it will keep in a portfolio, and is rendered sensitive to light by washing it over with a solution of nitrate of silver.

4. Iodized paper is washed with a mixture of twenty-six parts of a saturated solution of gallic acid to one part of the solution of nitrate of silver ordinarily used. It can then be dried without fear of spoiling, may be kept a little time, and used without further preparation.

5. The improvement of photographic drawings by exposing them twice the usual time to the action of sun-light. The shadows are thus rendered too dark, and the lights are not sufficiently white. The drawing is then washed, and plunged into a bath of iodide of potassium, of the strength of 500 grains to each pint of water, and allowed to remain in it for one or two minutes, which makes the pictures brighter, and its lights assume a pale yellow tint. After this, it is washed, and immersed in a hot bath of hyposulphite of soda until the pale yellow tint is removed, and the lights remain quite white. The pictures thus finished have a pleasing and peculiar effect.

6. The appearance of photographic pictures is improved by waxing them, and placing white or coloured paper behind them.

7. Enlarged copies of daguerreotypes and calotypes can be obtained by throwing magnified images of them, by means of lenses, upon calotype paper.

8. Photographic printing. A few pages of letter-press are printed on one side only of a sheet of paper, which is waxed if thought necessary, and the letters are cut out and sorted; then, in order to compose a new page, a sheet of white paper is ruled with straight lines, and the words are formed by cementing the separate letters in their proper order along the lines. A negative photographic copy is then taken, having white letters on a black ground; this is fixed, and any number of positive copies can be obtained. Another method proposed by the patentee is to take a copy by the camera obscura from large letters painted on a white board.

9. Photographic publication. This claim of the patentee consists in making, first, good negative drawings on papers prepared with salt and ammonio-nitrate of silver; secondly, fixing them by the process above described; thirdly, the formation of positive drawings from the negative copy, and fixing.

These claims, taken from the specification as published in the *Repertory of Patent Inventions*, are preserved in their original form, for the purpose of showing how much that is now fully accomplished was the result of Mr. Talbot's discoveries.

CHAPTER VII.

ALBUMEN AND GELATINE ON PAPER.

The use of organic matter in facilitating the change of silver salts very early engaged the attention of Sir John Herschel, and following his suggestions, various organic bodies have been employed, and especially albumen and gelatine. Many of the French photographers have employed isinglass with very considerable apparent advantage, and amongst these M. Gustave Le Gray has been especially successful. For negative paper he directs that three hundred grains of isinglass shall be dissolved, by means of a water bath, in one pint and three-quarters of distilled water. To this solution while warm is added—

Iodide of Potassium, . .	400 grains.
Bromide of Potassium, . .	120 ,,
Chloride of Sodium, .	48 ,,

When these salts are well dissolved, and the solution filtered, it is to be put still warm in a large dish. Into this plunge your paper completely, leaf by leaf, one on the other, taking care to prevent air-bubbles from adhering to the paper. Put about 20 leaves at a time into the dish, then turn the whole, those at the top to the bottom, then take them out one by one, and hang them by one corner, with a pin bent like the letter S, to dry spontaneously.

When hung up, attach to the opposite corner a small piece of bibulous paper, which will facilitate the drying.

When the paper is dry cut it the size required, and preserve it in a portfolio for use; this paper may be made in the day-time, as it is not sensitive to light in this state.

The bromide does not, in this case, act as an accelerator, as it does on the silver plates of the daguerreotype, because, instead of quickening, it retards the operation a little; its action is to preserve from the gallic acid the white of the paper, which would blacken more rapidly if you employed the iodide of potassium alone.

Second Operation.—Prepare, by the light of a taper, the following solution in a stoppered bottle:—Distilled water, six fluid ounces; crystallized nitrate of silver, 250 grains.

When the nitrate is dissolved, add one fluid ounce of crystallizable acetic acid: be careful to exclude this bottle from the light, by covering it with black paper. This solution will keep good until the whole is used.

When you wish to operate, pour the solution upon a porcelain or glass slab, surrounded with a glass or paper border to keep the liquid from running off. The safest practice is to take the solution out of the bottle by means of a pipette, so as to prevent the distribution of any pellicle of dust or other impurity over the glass slab.

Take a sheet of the iodized paper by two of the corners, holding them perpendicularly, and gently lower the middle of the paper upon the centre of the slab; gradually depress until the sheet is equally spread; repeat this operation several times until the air-bubbles disappear; take also the precaution to keep the upper side of the paper dry.

In order to prevent the fingers from spotting the paper, pass a bone paper knife under the corner of the sheet, to lift it from the slab between that and the thumb.

Let the sheet remain upon the slab until the formation of the chloro-bromo-iodide of silver is perfect.

This may be known by the disappearance of the violet colour which the back of the paper at first presents; it must not be left longer, otherwise it would lose its sensitiveness.

The time required to effect this chemical change is from one to five minutes, depending upon the quality of the paper.

Spread upon a glass, fitted to the frame of the camera, a piece of white paper well soaked in water; upon this place the prepared sheet, the sensitive side upwards.

The paper which you place underneath must be free from spots of iron and other impurities.

It is also necessary to mark the side of the glass which ought to be at the bottom of the camera, and to keep it always inclined in that direction when the papers are applied; if this precaution is neglected, the liquid collected at the bottom, in falling over the prepared paper, would produce spots. The paper thus applied to the glass will remain there for an hour without falling off, and can be placed within that time in the camera obscura.

When going to take a proof at a distance, moisten the sheet of lining paper with a thick solution of gum arabic: we thus preserve for a longer time its humidity and adhesion.

When the sheet of lining paper adheres well to the glass, it should not be removed, but only moistened afresh with water, after which you may apply another sheet of the sensitive paper.

In preparing several sheets of the sensitive paper at a time, it is not necessary to wash the slab for each sheet; you need only draw over it a piece of white paper to remove any dust or pellicle formed.

When your operations are finished, you may pour back the aceto-nitrate of silver into a bottle, and reserve it for another time.

The necessity of employing these papers in a wet state is their most objectionable quality, but certainly the results obtained by strict attention to these directions are often exceedingly beautiful. For developing the image the following is recommended, which does not, however, differ essentially from the developing processes already described.

Make about a pint bottle of saturated solution of gallic acid, using distilled water. Gallic acid being but slightly soluble in water, we have only to add more of it than will dissolve, and we thus insure constant saturation. Decant a portion into a smaller bottle for general use, and fill up the other bottle with water; you will thus always have a clear saturated solution.

Pour upon a slab of glass, kept horizontal, a little of this liquid, spreading it equally with a slip of paper, then apply the paper which has been exposed so that the face of the paper is uniformly spread upon the fluid, being careful to keep the back dry. Watch its development, which is easily observed through the back of the paper; since as long as the back of the image does not begin to spot you are safe.

When it is rendered very vigorous, remove it quickly to another clean slab, and well wash it in several waters, occasionally turning it, and gently passing the finger over the back.

The appearance of the image at the end of this process will enable you to judge if it was exposed in the camera the proper time.

If it becomes a bluish-gray all over, the paper has been exposed too long; if the strongest lights in the object, which should be very black in the negative, are not deeper than the half-tints, it bas still been too long exposed; if, on the contrary, it has been exposed too short a time, the lights are but slightly marked in black.

If the time has been just right, you will obtain a proof which will exhibit well-defined contrasts of black and white, and the light parts will be very transparent. The operation is sometimes accelerated by warming the gallic acid, and by this process the dark parts of the picture are rendered very black.

To fix these negative proofs, a very strong solution of hyposulphite of soda,—about one ounce of the hyposulphite of soda to eight fluid ounces of water,—is employed, and the picture is allowed to remain in it until every trace of yellowness is removed from the paper.

The ALBUMINIZED PAPER for negative pictures is now very rarely employed, but as some amateurs may be desirous of trying it, the following is the best mode of proceeding:—Beat the white of eggs into a froth; then set the fluid aside, at rest, and, when perfectly clear, make with it the following solution:—

White of eggs, . . .	2 fluid ounces and a-half.
Iodide of potassium, ...	56 grains.
Bromide of potassium, . . .	15½ ,,
Chloride of sodium, ...	4 ,,

Pour the solution into a dish placed horizontally, taking care that the froth has entirely disappeared; then take the paper that you have chosen, and wet it on one side only, beginning at thê edge of the dish which is nearest to you, and with the largest side of the sheet; placing the right angle on the liquid, and inclining it towards you, advance it in such a manner as to exercise a pressure which will remove the air-bubbles. Place before you a light, so as to be able to perceive the bubbles, and to push them out if they remain.

Let the leaf imbibe the fluid for a minute at most, without disturbing it; then take it up gently, but at once, with a very regular movement, and hang it up by the corner to dry.

You prepare thus as many leaves as you wish in the same bath, taking care that there is always about a quarter of an inch in depth of the solution in the dish; then place your sheets (thus prepared and dried) one on the other between two leaves of white paper, and pass over them several times a very hot iron, taking out a leaf each time; you will thus render the albumen insoluble.

The iron should be as hot as it can be without scorching the paper.

Then use this negative paper exactly like the paper described with the gelatine; only great attention must be observed that the immersion in the aceto-nitrate bath is instantaneous, and that the air-bubbles are immediately driven out; for every time you stop you will make stains on the paper. It is also necessary in this process to warm moderately the gallic acid.

The use of albumen on paper for positive printing has become general, but I do not conceive that it offers any peculiar advantages. It is quite true that a fine tone can be produced on the positive prints, but it is somewhat doubtful if these are not obtained at a sacrifice of the permanent character of the picture.

The advantages of albumen are, that it secures, if properly employed, a uniform surface on which to receive the image.

Albuminized Positive Paper is thus prepared:—Take of the whites of eggs six ounces, distilled water ten ounces, common salt one ounce. Dissolve the salt in the water, and add this to the white of eggs. With a *wooden* spoon or fork beat the whole into a froth, the longer it is beaten the more transparent will be the subsequent fluid; let it stand, carefully covered for twenty-four hours, then strain it through double muslin, and it is fit for use.

Pour some of the solution into a dish, and float a sheet of paper on it for four minutes, taking care that air-bubbles do not prevent any part of the paper from touching the fluid. Then hang it up to dry, when thoroughly dry, place it between two sheets of glazed paper, and pass a hot iron over it. The object of this is to render the albumen insoluble, and care must be taken to employ the iron sufficiently, but not too hot. Excite this paper by placing its albuminized side on the following solution:—Nitrate of silver one hundred grains, distilled water one ounee.

CHAPTER VIII.

THE USE OF ALBUMEN ON GLASS PLATES.

In the *Technologist* for 1848, M. Niepce de Saint Victor published his mode of applying albumen to glass plates. M. Blanquart Everard followed; and successively albumen, gelatine, serum, and other animal substances, have been recommended for application on glass: but, few of them have been found to answer so perfectly as albumen applied according to the directions of M. Le Gray.

He recommends that the whites of fresh eggs, equal to about five fluid ounces, be mixed with not more than 100 grains of iodide of potassium,—about twenty grains of the bromide, and half that quantity of common salt.

He then directs you to beat this mixture in a large dish with a wooden fork, until it forms a thick white froth; to let it repose all night, and the next day to decant the viscous liquid which has deposited, and use it for the preparation of your glasses.

For this purpose take thin glass, or, what is much better, *ground glass, on which the adherence is more perfect;* cut it the size of your camera frame, and grind the edges.

The success of the proof is, in a great measure, due to the evenness of the coat of albumen.

To obtain this, place one of your glasses horizontally, the unpolished side above (if you use ground glass, which I think preferable), and then pour on it an abundant quantity of the albumen. Take a rule of glass, very straight, upon the ends of which have been fastened two bands of stout paper steeped in white wax: hold this with the fingers in such a manner that they will overlap the sides of the glass plate about one-eighth of an inch. You then draw the rule over the glass with one sweep, so as to take off the excess of albumen. The object of the slip of paper is to keep the glass rule from the surface of the plate, and insure a thin but even coating of the albuminous mixture.

Thus, in making the paper band more or less thick, you vary the thickness of the coating. Or you may arrive at the same result by pasting two narrow bands of paper on the sides of the plate, and passing simply the rule down. I prefer the first means, because, with the second, one is always sure to soil the glass in sticking on the paper.

You must never go the second time over the glass with the rule, or you will make air-bubbles. When thus prepared, permit the plate to dry spontaneously, keeping it in a horizontal position and free from dust. When the coat of albumen is well dried, submit your glasses to the temperature of 160° to 180° Fahrenheit; this you may do either before a quick fire, or by shutting them up in an iron saucepan well tinned, with a cover; you then place the saucepan in a bath of boiling water: the action of the heat hardens the albumen; it becomes perfectly insoluble, and ready to receive the aceto-nitrate of silver.

The glass thus prepared may be kept for any length of time. I prepare the first coat also by saturating the former mixture with gallic acid, which gives it more consistency and greater sensitiveness.

When you wish to make a proof (by using the preparation moist), you plunge the glass thus prepared in a bath of aceto-nitrate of silver. Nitrate of silver 250 grains, distilled water six fluid ounces, acetic acid (crystallizable) one ounce. This operation is very delicate, because the least stoppage in its immersion in the bath will operate on the sensitive coating, and cause irregularities which nothing can remedy.

To obtain this instantaneous and regular immersion, take a box with glass sides, a trifle larger than the plate, and about half an inch wide, with wooden grooves, similar to those in the Daguerreotype plate box: into this pour the aceto-nitrate, and let the prepared glass fall into it with a single movement, leaving it to soak four or five minutes in the bath; then remove it, wash well with distilled water, and expose in the camera while moist. The time will vary from two to thirty minutes, or nearly double that time *if the glass is dry.*

When you wish to operate with the glasses dry instead of moist, it is proper to dip them in a bath of gallic acid a quarter of an hour after they are taken out of the aceto-nitrate bath; then well wash them with distilled water, and dry.

Of course, the operation must be performed with great care, and in an apartment which is artificially illuminated.

When you take the plate out of the camera, you develop the image in the same way as the negative on paper, by putting it into a bath of saturated gallic acid: when it is well developed, you fix it by the same method indicated for the paper.

To obtain a positive proof, it is sufficient to apply on the negative proof a sheet of common positive paper, or, a sheet of the positive albuminized paper, which is previously described.

Niepce de Saint Victor has recently published a process in which he employs starch instead of albumen on the glass plates. The main features of this process are as follow:—About seventy grains of starch are rubbed down with the same quantity of distilled water, and then mixed with three or four ounces more water; to this is added 5½ grains of iodide of potassium dissolved in a very small quantity of water, and the whole is boiled until the starch is properly dissolved. With this the glass plates are carefully covered, and then placed to dry on a perfectly horizontal table. When thoroughly dried, the aceto-nitrate of silver is applied by wetting a piece of paper, placing this on the starch, and over it another piece of paper wetted with distilled water. This mode of preparation furnishes, it is said, tablets of great sensibility; but the starch is liable to break off from the glass, and there is much difficulty in spreading it uniformly in the first instance.

Some very ingenious experiments were made by Mr. Malone, from whose communications on this subject the following remarks are quoted:—

"To the white of an egg its own bulk of water is to be added; the mixture, beaten with a fork, is then strained through a piece of linen cloth, and preserved for use in a glass stoppered bottle; then a piece of plate glass, cleaned with a solution of caustic potash, or any other alkali, is to be washed with water and dried with a cloth. When the glass is about to be used, breathe on it, and rub its surface with clean new blotting paper; then to remove the dust and fibres which remain, use cotton-wool, or a piece of new linen. Unless this latter, and, indeed, every other precaution, is taken to prevent the presence of dust, the picture will be full of spots, produced by a greater absorption of iodine (in a subsequent process) in those than in the surrounding parts.

"On the clear glass pour the albumen, inclining the plate from side to side until it is covered; allow the excess to run off at one end at the corners, keeping the plate inclined, but nearly vertical. As soon as the albumen ceases to drop rapidly, breathe on or warm the lower half of the plate; the warmth and moisture of the breath will soon cause it to part with more of its albumen, which has now become more fluid; of course, care must be taken to warm only the lower half. Wiping the edges constantly, hastens the operation. Until this plan was adopted, the coatings were seldom uniform; the upper half of the plate retained less than the lower. When no more albumen runs down, dry the plate by a lamp, or by a common fire, if the dust that it is inclined to impart be avoided.

"The next operation is to iodize the plate. Dilute pure iodine with dry white sand in a mortar, using about equal parts of each; put this mixture into a square vessel, and place over it the albuminized plate, previously heated to about 100° Fah. As soon as the film has become yellow in colour, resembling beautifully stained glass, remove the plate into a room lighted by a candle, or through any yellow transparent substance, yellow calico for instance, and plunge it vertically and rapidly into a deep narrow vessel containing a solution of 100 grains of nitrate of silver and fifty minims of glacial acetic acid, diluted with five ounces of distilled water. Allow it to remain until the transparent yellow tint disappears, to be succeeded by a milky-looking film of iodide of silver. Washing with distilled water leaves the plate ready for the camera.

"It may be here noted that the plate is heated in iodizing for the purpose of accelerating the absorption of the iodine: an exposure to the vapour for ten minutes, with a few seconds' immersion in the silver solution, has been found to be sufficient."

Hydrochloric acid, chlorine or bromine, may be used with the iodine to give increased sensibility to the plate, as described in the Daguerreotype processes.

The plate is removed from the camera, and we pour over it a saturated solution of gallic acid. A negative calotype image is the result. At this point previous experimentalists have stopped. We have gone farther, and find that by pouring upon the surface of the reddish-brown negative image, during its development, a strong solution of nitrate of silver, a remarkable effect is produced. The brown image deepens in intensity until it becomes black. Another change commences—the image begins to grow lighter; and finally, by perfectly natural magic, black is converted into white, presenting the curious phenomenon of the change of a Talbotype *negative* into apparently a positive Daguerreotype, the positive still retaining its negative properties when viewed by transmitted light.

To fix the picture, a solution of one part of hyposulphite of soda in sixteen parts of water is poured upon the plate, and left for several minutes, until the iodide of silver has been dissolved. Washing in water completes the process.

"The phenomenon of the Daguerreotype," says Mr. Malone, "is in this case produced by very opposite agency, no mercury being present; metallic silver here producing the lights, while in the Daguerreotype it produces the shadows of the picture. We at first hesitated about assigning a cause for the dull white granular deposit which forms the image, judging it to be due simply to molecular arrangement. Later experiments, however, have given us continuous films of bright metallic silver, and we find the dull deposit becomes brilliant and metallic when burnished. It should be observed that the positive image we speak of is on glass, strictly analogous to the Daguerreotype. It is positive when viewed at any angle but that which enables it to reflect the light of the ray. This is one of its characteristics. It must not be confounded with the continuous film image which is seen properly only at one angle; the angle at which the other ceases to exist. It is also curious to observe the details of the image, absent when the plate is viewed negatively by transmitted light, appear when viewed positively by reflected light."

Besides albumen, several other preparations have been employed, and recommended for procuring an absorbent film upon glass plates—amongst others, the serum of milk has been used by M. Blanquart Everard; others combine with the albumen or gelatine, grape sugar and honey; the object of these being to quicken the process, which they appear to do in virtue of their power of precipitating the metals from their solutions.

Blanquart Everard has lately communicated the following to the Paris Academy of Sciences, as an instantaneous process:—"Fluoride of potassium, added to iodide of potassium in the preparation of the negative proof, produces instantaneous images on exposure in the camera. To assure myself of the extreme sensibility of the fluoride, I have made some experiments on the slowest preparations employed in photography—that of plates of glass covered with albumen and iodide, requiring exposure of at least sixty times longer than the same preparation on paper. On adding the fluoride to the albumen and iodide, and substituting for the washing of the glass in distilled water after treatment with the aceto-nitrate of silver, washing in fluoride of potassium, the image appears immediately on exposure in the camera obscura. I have indeed obtained this result (but under conditions less powerful in their action) without the addition of the fluoride to the albumen, and by the immersion only of the glass plate in a bath of fluoride after its passage through the aceto-nitrate of silver. This property of the fluorides is calculated to give very valuable results, and will probably cause, in this branch of photographic art, a change equally as radical as that effected by the use of bromine on the iodized silver plates of Daguerre." A process published in the author's *Researches on Light*, in 1844, and named the Fluorotype, sufficiently establishes his claim to priority in the use of the fluorides.

Messrs. Ross and Thompson of Edinburgh have been eminently successful operators with the albumen process, many of their pictures, which are of large size, exhibiting more artistic effect than is obtained by any other photographers. Some of the positives produced are very fine. At the meeting of the British Association in that city, these gentlemen exhibited some positive images on glass plates; these were backed up with plaster of Paris, for the purpose of exalting the effects, which were exceedingly delicate and beautiful. The mode adopted by these photographers for coating their glass plates with albumen is very ingenious. The glass plate is placed upon two long cords laid across,—the four ends of the cords being taken up together, the glass hangs between them; the whole arrangement is now twisted up tightly; albumen is now poured in the centre of the plate, and it is set free. By rapidly untwisting, the albumen spreads out over the glass, and flies off at the sides. Thus by the influence of centrifugal force, a very perfect film of albumen is produced.

Messrs. Langenheim, of Philadelphia, however, in 1851 introduced into this country specimens, which they termed Hyalotypes. These were positive pictures, copied on glass from negatives, obtained upon the same material. Their peculiarity was the adaptation of them for magic lantern sliders. The process by which they were produced is not published, but judging from the effects obtained, the probability is that a very slight variation only from the processes described has been made. The idea was an exceedingly happy one, as by magnifying those images which are of the utmost delicacy and the strictest fidelity, perfect reflexes of nature are obtained.

There can be no doubt but other means of coating glass with sensitive materials may be employed. Certainly the use of albumen is a ready method, but this medium appears to interfere with the sensibility which it is so desirable to obtain. As stated, by using combinations of iodine and fluorine salts, there is no doubt but the sensibility may be most materially improved, and we find many of the continental photographers using honey and grape sugar with much advantage for the purpose of securing increased sensibility.

CHAPTER IX.

CALOTYPE PROCESS ON WAXED PAPER.

The most successful operators with waxed paper have been M. Le Gray on the Continent, and Mr. Fenton in England. In a work published by Le Gray, he has entered into the question of the physical agencies which are active in producing the chemical changes on the various preparations employed. Throughout the essay, he evidently labours under an entire misconception of the whole of the phenomena, curiously enough giving a false interpretation to every fact. His manipulatory details are very perfect, but his scientific explanations are only so many sources of error.

First Process: To Wax the Paper.—This process divides itself into several parts, waxing the paper being the first. For this purpose he takes the paper prepared by Lacroix d'Angoulême, or that of Canson Brothers of Annonay. A large plate of silvered copper, such as is employed for the Daguerreotype, is obtained and placed upon a tripod, with a lamp underneath it, or upon a water-bath. The sheet of paper is spread upon the silver plate, and a piece of pure white wax is passed to and fro upon it until, being melted by the heat, it is seen that the paper has uniformly absorbed the melted wax. When this has thoroughly taken place, the paper is to be placed between some folds of blotting-paper, and then an iron, moderately hot, being passed over it, the bibulous paper removes any excess of wax, and we obtain a paper of perfect transparency.

Second Process: To Prepare the Negative Paper.—In a vessel of porcelain or earthenware capable of holding five pints and a quarter of distilled water, put about 4,000 grains of rice, and allow them to steep until the grains are but slightly broken, so that the water contains only the glutinous portion. In a little less than a quart of the rice solution thus obtained, dissolve—

Sugar of milk, ...	620 grains.
Iodide of potassium, ...	225 ,,
Cyanide of potassium, ...	12 ,,
Fluoride of potassium, ...	7 ,,

The liquid, when filtered, will keep for a long time without alteration.

When you would prepare the paper, some of this solution is put into a large dish, and the waxed paper, sheet by sheet, is plunged into it, one over the other, removing any air-bubbles which may form. Fifteen or twenty sheets being placed in the bath, they are allowed to soak for half an hour, or an hour, according to the thickness of the paper. Turning over the whole mass, commence by removing the first sheet immersed, and hooking it up by one corner with a pin bent in the shape of the letter S, fix it on a line to dry, and remove the drop from the lower angle by a little bundle of blotting-paper. M. Le Gray then remarks that French and English paper should never be mixed in the same bath, but prepared separately, as the "English paper contains a free acid, which immediately precipitates an iodide of starch in the French papers and gives to them a violet tint." The paper being dry is to be preserved for use in a portfolio.

Third Process: To render the Waxed Paper Sensitive.—Make a solution of

Distilled water, ...	2325 grains.
Crystallized nitrate of silver, . .	$77\frac{1}{2}$,,

and when this is dissolved add of

Crystallized acetic acid, . . .	186 grains.

Papers prepared with this solution will keep well for a few days. M. Le Gray, however, recommends for his waxed paper, and for portraits, that the quantity of nitrate of silver be increased to 155 grains, and that it should be used moist.

The method of preparing these papers is to float upon an horizontal plate of glass either of the above solutions, and taking a piece of the iodized paper, to carefully place it upon the fluid, taking great care that no air-bubbles interpose. The paper must remain a short time in contact with this sensitive fluid until chemical combination is effected. Four or five minutes are required for some papers, and eight or ten seconds are sufficient for other kinds. When a violet tint appears the paper should be removed.

For those papers which it is desirable to keep for some time, as during a journey, it is recommended that into one vessel of porcelain you put about five or six millilitres of the strong aceto-nitrate above described, and into another some distilled water; you plunge completely both sides of the waxed and iodized paper in the first fluid, and allow it to remain about four or five minutes; withdraw it, and plunge it immediately into the bath of distilled water, in which let it soak for not less than four minutes. When these papers are carefully dried they may be preserved for some time for use, and by lessening the dose of nitrate of silver this period may be considerably prolonged. It will of course be understood by all who have followed the processes described up to this point, that the papers which are prepared for keeping are not those which are the most sensitive; hence it is necessary to expose such a much longer time in the camera, than those prepared by the stronger solution of silver. The more sensitive variety, under ordinary circumstances of light, will require an exposure in the camera of about twenty seconds, the less sensitive demanding about ten or fifteen minutes, according to the circumstances of light.

Fourth Process: The Development of the Image.—The picture is developed by the aid of gallic acid dissolved in distilled water. Le Gray finds the following to be the best proportions:—

Distilled water, ...	40 fluid ozs.
Gallic acid, ...	60 grains.

The paper is to be plunged into this solution, and allowed to remain until it is fully developed. The time will vary from ten minutes to two hours or more, according to the intensity of the rays incident on the paper when in the camera. The development of the image is much accelerated by the addition of fifteen or twenty drops of the aceto-nitrate of silver.

Fifth Process: Fixing.—It is found convenient often, when on a journey, to give a temporary fixedness to the pictures obtained, and to complete the process with the hyposulphite at any time on your return home. A wash of 360 grains of bromide of potassium to two quarts of water is the strength which should be employed. The process of fixing with hyposulphite of soda, consists, as in other preparations, simply in soaking the paper until the yellow tint of the iodide has disappeared. The details are given in the chapter on fixing Photographs.

CHAPTER X.

THE DAGUERREOTYPE.

It is of course now well understood that the Daguerreotype is on a plate of copper coated with silver; the first process is therefore—

Polishing the Plate.—Upon this subject but little remains to be added to what is stated in Daguerre's earliest form of manipulation, described in the first part of this volume.

It is of the utmost importance that a very perfect mirror surface should be produced, and to ensure the utmost freedom from all organic matter during the polishing, the plate-holder represented in two positions by *e e*, in vignette above chap. 1, has been devised. The plate-holder is secured to a table by a clamp, and the plate to be polished is fixed upon the horizontal surface of the plate-holder by means of four binding-screws placed at its corners. The plate having undergone the preliminary rubbing, which, as being a comparatively coarse operation, need not be further detailed than it is in the earlier section, and having been fixed on the holder, the last polish is to be given to it. The hand-buff, *i*, in the vignette, is to be dusted over with animal charcoal, and moistened with a little spirits of wine: some operators employ tripoli in a state of impalpable powder mixed with essential oil of lavender. If, however, any essential oil is used, it must be ascertained to be quite free from castor oil,—with which it is very commonly adulterated,—by placing a drop on a piece of paper: if it is a pure essential oil, it will, when warmed, entirely evaporate, but if not, a greasy spot will remain.

In M. Claudet's establishment, where, from long experience, the best modes of manipulation are introduced, the last buffing is effected in a somewhat different manner.

In a box on a roller, to which there is a handle (fig. 31), is placed a long piece of drab-coloured velvet, which can be drawn out and extended, by means of a second roller, upon the perfectly flat table. The first foot or two, for example, is drawn out: the plate, which has already received its preliminary polishing, is placed face downwards, and being pressed close with the fingers, a rapid circular motion is given to it, and in a few minutes it receives its highest lustre. As the velvet becomes blackened by use it is rolled off, the portion remaining in the box being always perfectly clean, and ready for use. The plate is now ready for receiving

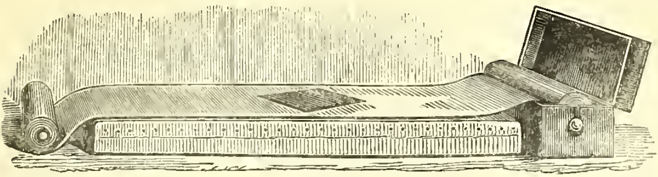

Fig. 31.

its sensitive coating, and, to avoid the chance of the surface touching any other object, M. Claudet adopts the simple but most effective mode of pushing it from the buff into a spherical wooden bowl, in which the plate rests by its four corners in perfect security.

As the edges of the metallic plates are generally sharp, they would often cut the buffs, were that accident not prevented by a suitable precaution. Fig. 32 represents an apparatus called a *plate-bender*. The surface *a* is perfectly horizontal, and has a steel border near the bar *b*: upon the bar *b* runs

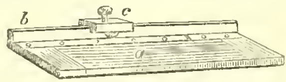

Fig. 32.

a press that carries a steel knife edge so rounded as to be able to bend a plate but not to cut it. The silver plate that is to be buffed is placed on this apparatus with an edge close to the back bar, and the press is then run along it from end to end, by which means the edge of the silver plate is bent downwards in a very slight degree, but sufficient to prevent any cutting action on the buffs. All the four edges of each plate are bent in the same manner.

To give the Sensitive Surface to the Plate.—Various compounds, called accelerating liquors, have been introduced, in all of which we have combinations in various proportions of either bromine and iodine, or chlorine and iodine, and sometimes of the three. These are known by the names of Eau Bromeé, or Bromine Water, Bromide of Iodine, Redman's Sensitive Solution, Hungarian Liquid, and Woolcott's Accelerating American Fluid. These accelerating compounds are employed after the plate has been subjected to the vapour of iodine. They all require to be diluted with water until about the colour of pale sherry. The plate is exposed to the influence of the vapour which is escaping from the solution used in the same manner as with the iodine, but the colour to be attained differs according to the solution employed. An iodizing box is shown at *c*, in the vignette, at the bottom of this some iodine is strewed, and in general it is covered with a little sand or a card;—the object of this is to avoid an irregular action on any part of the plate: the box being adjusted with a cover, the iodine is preserved from evaporation, and lasts a long time. When the plate has assumed its fine straw-yellow colour in the iodine box, it is removed to the action of the accelerating agents, liquid or otherwise, as the case may be. The following rules will guide the experimenter in using the different preparations. If bromide of iodine be used as the accelerating agent, the plate should remain over the iodine until it is of a pure yellow tint, and over the bromine till of a deep rose colour. By observing the time of exposure necessary to render a plate sensitive, any number of plates may be prepared exactly alike, provided that the same quantity of the solution, always of an uniform strength, be put into the pan. By using a much weaker solution a longer exposure is then necessary, but the plate becomes more evenly covered, and there is less danger of having it too much or too little acted upon by the accelerator. The same remark will apply to other accelerating solutions. If Redman's solution, or the Hungarian liquid, a pale yellow and light rose will be found most sensitive. As a general rule, if the yellow colour produced by the iodine be pale, the red should be pale also; if deep, the red must incline to violet. When several plates are to be prepared at one time, the same solution will serve for all; but it seldom answers to preserve the mixture for any long time; and its use, after keeping, is one great cause of the failures which so annoy amateurs. The bromine contained in these solutions is very subtile, and escapes, leaving little else but iodine remaining, which will, after some time, give a red colour to the plate, without rendering it sensitive, entirely disappointing the expectations of the operator. Eau bromée, or bromine water, which is very easily prepared, is extensively used on the Continent, and is simple in its use. If a certain quantity of an uniform solution be placed in the pan, for each plate prepared, one observation will suffice to determine the time of exposure; if not, the colour must guide the operator, varying according to the degree of colour obtained over the iodine: thus, if the first colour obtained be a light yellow, the plate should attain a full golden tint over the iodine, and may then be retained over the bromine until it acquires a rose colour. If iodized of a golden-yellow, then, in the second operation, it is taken to a pale rose, and in the third to a deep rose. If in the first of a full red, in the second to a deep red, and lastly to a grey; if the first to a deep red, in the second to a light blue, and in the third, to a white, or nearly the absence of all colour.

Experience, however, must invariably guide the operator, as scarcely any two solutions, though professedly the same in character, possess the same properties.

In a pamphlet published by M. Fizeau, bromine water is recommended to be prepared as follows:—"To prepare a solution of bromine, of a fixed proportion and convenient strength to operate with, I, in the first place, make a saturated solution of bromine in water; this is prepared by putting into a bottle of pure water a great excess of bromine, agitating strongly for some minutes, and before using allowing the bromine to separate. Now, a definite quantity of this saturated water is to be mixed with a definite quantity of plain water, which will give a solution of bromine always of the same strength: this mixture is conveniently made in the following manner:—The apparatus necessary is a *dropping tube*, which is also required for another part of the process, capable of holding a small definite quantity, and a bottle having a mark to indicate a capacity equal to thirty times that of the dropping tube: fill the bottle with pure water to the mark, then add, by means of the dropping tube, the proper quantity of the saturated solution of bromine.

"The purity of the water is of some importance: the foregoing proportions refer to the pure distilled water, and it is well known that the water of rivers and springs is not pure; but these different varieties can be used as if they were absolutely pure water by adding a few drops of nitric acid till they taste slightly acid; two or three drops to the pint is generally sufficient.

"The liquid produced, which is of a bright yellow colour, ought to be kept in a well-stopped bottle; it is the normal solution, and I shall call it simply bromine water, to distinguish it from the saturated solution.

"**Bromine Box.**—The box I employ for subjecting the plate to the vapour of the bromine water is constructed in the following manner:—It consists of a box lined with a varnish, which is not acted on by bromine; its height is about four inches; the other dimensions are regulated by the size of the plate, which ought to be at least half an inch all round, short of the sides of the box; it is composed of three separate portions—the cover, which is the frame holding the plate, the body of the box, and the bottom, upon which is placed the vessel for the bromine; this moveable bottom is slightly hollowed, so that the bromine vessel may always be placed in exactly the same position."

Few men have done more for photography than M. Fizeau, and in nearly all his suggestions he has been exceedingly happy: the bromine water thus prepared is used with the best effect by our most eminent daguerreotype artists.

Bromide of iodine is best prepared by the method of M. de Valicours, which is as follows:—"Into a bottle of the capacity of about two ounces, pour thirty or forty drops of bromine, the precise quantity not being of importance. Then add, grain by grain, as much iodine as the bromine will dissolve till quite saturated. This point is ascertained when some grains of the iodine remain undissolved. They may remain in the bottle, as they will not interfere with the success of the preparation.

"The bromide of iodine thus prepared, from its occupying so small a space, can very easily be carried, but in this state it is much too concentrated to be used. When it is to be employed, pour a small quantity, say fifteen drops, by means of a dropping-tube, into a bottle containing about half an ounce of filtered river water. It will easily be understood that the bromide of iodine can be used with a greater or less quantity of water, without altering the proportion which exists between the bromine and iodine."

Mr. Goddard, on December 12, 1840, published a letter in the *Literary Gazette* on the use of bromide of iodine as an accelerating agent, but chloride of iodine was first employed by M. Claudet in 1841, and is prepared by merely placing iodine in an atmosphere of chlorine. Chloride of bromine is made by mixing two drachms of a saturated solution of bromine with fifteen drops of strong muriatic acid and about nine or ten ounces of water. The Hungarian mixture appears to be a similar compound to this.

For the following exceedingly convenient preparations we are indebted to Mr. R. J. Bingham, who has for some time, with much success, devoted his attention to the improvement of photographic processes. The following extracts are from the *Philosophical Magazine* for October, 1846:—

"*An Improvement in the Daguerreotype Process by the application of some new compounds of bromine, chlorine, and iodine, with lime.*—All persons who have practised the daguerreotype must have remarked that in warm weather a considerable deposition of moisture takes place upon the glass or slate cover used to confine the vapour in the bromine or accelerating pan. This moisture must also necessarily condense upon the cold metallic surface of the plate during the time it is exposed to the bromine vapour. In fact, I have been informed by a number of professional daguerreotypists (and I have experienced the difficulty myself), that they were unable to obtain perfect pictures during the excessive heat of the late season; and a very clever and enterprising operator, who last year made a tour on the Continent, and brought home some of the finest proofs I have ever seen, entirely failed this season in obtaining clear and perfect pictures, from the constant appearance of a mist or cloud over the prepared surface.

This appears to be caused by the deposition of moisture upon the plate, arising from the water in which the bromine is dissolved. To obviate this, some have recommended the pan to be kept at a low temperature in a freezing mixture; and M. Daguerre, in a communication to the French Academy of Sciences, recommends the plate to be heated: but in practice both these are found to be unsuccessful. (See Lerebours' *Traité de Photographie.*)

"It appeared to me, that if we could avoid the use of water altogether in the accelerating mixture, not only would the difficulty I have mentioned be avoided, but a much more sensitive surface would be obtained on the plate. With this view I endeavoured to combine bromine with lime, so as to form a compound analogous to bleaching powder. In this I was successful, and find that bromine, chloride of iodine, and iodine, may be united with lime, forming compounds having properties similar to the *so-called* chloride of lime.

"The bromide of lime* may be produced by allowing bromine vapour to act upon hydrate of lime for some hours: the most convenient method of doing this is to place some of the hydrate at the bottom of a flask, and then put some bromine into a glass capsule supported a little above the lime. As heat is developed during the combination, it is better to place the lower part of the flask in water at the temperature of about 50° Fah.: the lime gradually assumes a beautiful scarlet colour, and acquires an appearance very similar to that of the red iodide of mercury. The chloro-iodide of lime may be formed in the same manner: it has a deep brown colour. Both these compounds, when the vapour arising from them is not too intense, have an odour analogous to that of bleaching powder, and quite distinguishable from chlorine, bromine, or iodine alone.

"Those Daguerreotypists who use chlorine in combination with bromine, as in Woolcott's American mixture, or M. Guérin's Hungarian solution, which is a compound of bromine, chlorine, and iodine, may obtain similar substances in the solid state, which may be used with great advantage. By passing chlorine over bromine, and condensing the vapours into a liquid, and then allowing the vapour of this to act upon lime, a solid may be obtained having all the properties of the American accelerator;

* "I call this substance bromide of lime, although there is a difficulty as to the composition of bleaching powder, and which would also apply to the compounds I describe. Some chemists regard the *chloride of lime* to be a compound of lime, water, and chlorine. Balard thinks it is a mixture of hypochlorite of lime and chloride of calcium; and the view of Millon and Prof. Graham is, that it is a peroxide of lime, in which one equivalent of oxygen is replaced by one of chlorine."

or by combining the chloro-iodide of lime with a little of the bromide, a mixture similar to that of M. Guérin's may be produced : but I greatly prefer, and would recommend, the pure bromide of lime, it being, as I believe, the quickest accelerating substance at present known. By slightly colouring the plate with the chloro-iodide, and then exposing it for a proper time over the bromide, proofs may be obtained in a fraetion of a second, even late in the afternoon. A yellow eolour should be given by the use of the first substance; and the proper time over the bromide is readily obtained by one or two trials.* With about a drachm of the substance in a shallow pan, I give the plate ten seconds the whole of the first day of using the preparation, and add about three seconds for every succeeding one. The compound should be evenly strewed over the bottom of the pan, and will last, with care, about a fortnight.

"The great advantage of this compound is, that it may be used continuously for a fortnight without renewal; and, unlike bromine water, its action is unaffected by the ordinary changes of temperature."

The advantages of a dry material are so great, that the bromide of lime is now commonly used.

By the employment of these agents a sensitive coating is produced, upon which actinic changes are almost instantaneously made. The modes of proceeding to prepare the plates are similar to those already named.

The time necessary for the plate to be exposed to the action of the bromine water, if it be used, must be determined by experiment, for it will vary according to the size of the box and the quantity of liquid used. It is ordinarily between thirty and sixty seconds, the time varying with the temperature of the atmosphere : when once determined, it will be constant with the same box, the same strength of solution, and the same temperature.

The method of eoating the plate with bromine from the water which is most approved is as follows:—Place a pan in a properly prepared box, fill a pipette with bromine water, and pour it carefully from this into the pan, then close the vessel with a glass plate: the liquid must cover evenly the bottom of the pan; if not level, it must be adjusted: the level will be easily seen through the glass slide. When everything is thus arranged, the

* "It is better to count time both over the iodine and the bromide of lime: the exposure of the plate to the iodine, after it has received its proportion of bromine, should be one-third of the time it took to give it the first coating of iodine. We have found that if less iodine than this be allowed to the plate it will not take up so much mercury, neither will the picture produced be so bold and distinct."

plate previously iodized, is to be placed in its frame over the pan, the slide withdrawn, and the necessary time counted; after this has elapsed, the slide should be shut, and the plate immediately placed in the dark box of the camera.

For a second operation, this bromine water must be thrown away and a fresh quantity used. The bottle containing the bromine water should be kept away from the direct light of the sun, and care should be taken that no organic matter fall into the bottle, such as grease, chips of cork, &c. These enter into new combinations with the bromine, and lead to error as to the amount in solution.

Daguerre himself introduced some very considerable improvements in the process of iodizing. He avoided the use of metal strips, and gave some curious experiments on the action of edges, grooves, &c., in determining the deposition of vapour. M. Daguerre stated that, but for the difficulty of fixing them, the bands might be very much reduced in size; for it is sufficient for them to produce their effect that there be a solution of continuity between them; and this is proved by the fact that nearly the same result is obtained by engraving at the $\frac{1}{8}$th of an inch from the edge of the plate a line deep enough to reach the copper. The objections to this are, that during the polishing process the engraved line is filled with dust, and it retains water, which sometimes occasions stains. He then proposed, as a very great simplification of this process, that the plate should be laid flat in a shallow box containing two grooves, one to receive the plate, and the other a board saturated with iodine. Around the plate he places a border of either powdered starch or lime, and the iodine *descends* from the board to the tablet. The starch or lime absorbs the iodine with avidity, and thus prevents its attacking the edges of the silver, and the vapour is diffused with perfect evenness over it. Another advantage is, that the saturated board may be used for several days in succession, without being renovated.

M. Seguier somewhat modified even this process. A box of hardwood, varnished internally with gum lac, contains a lump of soft wood, furnished with a card of cotton sprinkled with iodine. Upon this is placed a plate covered with card-board on each of its faces. One of these card-boards furnishes, by radiation, to the metal the vapour of iodine, while the other returns to the cotton that which it had lost. It suffices to turn the plate from time to time, in order that the operation may go on with equal rapidity. A plate of glass is placed upon the upper card-board, where it is not operated on. The plate is sustained a little above the charged cotton by frames of hardwood varnished with gum lac. By increasing the distance between the cotton and the plate, or the contrary, we are enabled to suit the arrangement to the temperature of the season, and thus always operate with facility and promptitude. M. Seguier also states, that a single scouring with tripoli, moistened with acidulated water, is sufficient to cleanse the plates thoroughly, thus doing away with the tedious process of scouring with oil, and afterwards the operation of heating the tablet over a spirit lamp. M. Soliel has proposed the use of the chloride of silver to determine the time required to produce a good impression on the iodized plate in the camera. His method is to fix at the bottom of a tube, blackened within, a piece of card, on which chloride of silver, mixed with gum or dextrine, is spread. The tube thus disposed is turned towards the object of which we wish to take the image, and the time that the chloride of silver takes to become of a grayish slate colour, will be the time required for the radiations in the camera to produce a good effect on the iodated silver.

These remarks have been introduced as supplementary to the generally approved modes, as they are suggestive in themselves of still further improvements.

To Develop the Image formed on the Plate.—The plate, prepared by one of the methods directed, has been placed in the camera, and the image impressed upon it—attention being given to the points especially alluded to in the chapter "General Remarks on the use of the Camera Obscura."

The image is developed on the daguerreotype plate, as has been already described, by the use of mercurial vapour. In the original process (fig. 10), one form of a mercurial vapour-box is given; and in the vignette referred to, *d*, represents another.

It matters little in what manner the plate is placed in the mercurial bath; the mercury should be volatilized very slowly, and the image allowed to have its full development before it is removed from the box. Care should be taken that the operator avoids as much as possible contact with the mercurial vapour, since continued exposure to its influence might lead to serious inconvenience.

M. Claudet has adopted a most admirable arrangement in this respect, as is shown in the woodcut on the following page.

Fig. 33 represents a small dark chamber fixed outside the apartment in which the operations are carried on, but opening into it by means of sliding glass doors. On either side of the chamber are placed pieces of yellow glass, through which, on opening the shutters by which they are covered, a sufficient quantity of light is admitted to serve any useful purpose, without in any way interfering with the sensitive surfaces of the plates. Within this chamber are placed two mercury boxes, each containing a small quantity of that metal. One of these is shown in section. Each box is placed over a water bath, supplied by means of a pipe with water from a cistern above, and a small sand bath is placed between the mercury box and the water bath. By means of the gas burner beneath the box, the water is heated, the mercury volatilized slowly and deposited on the plates, which are fixed in the grooves shown on the sides of the box in section.

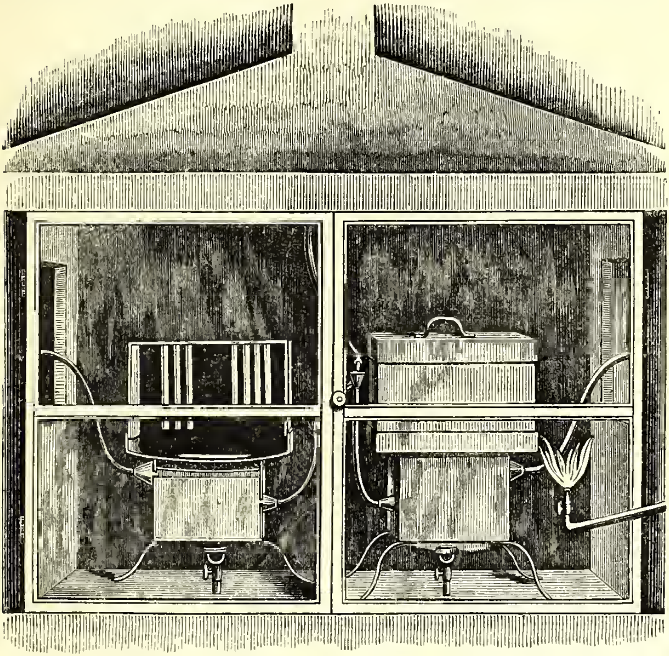

Fig. 33.

The windows being closed, any mercurial vapours which may escape from the box pass out into the air through proper ventilators, and the operator is thus protected from the injurious effects of the mercury.

Fixing the Daguerreotype Image.—It has already been stated that the solution of hyposulphite of soda is the most effective agent for removing all the unchanged iodide of silver, after the application of, and the development of the image by the mercurial vapour.

This being effected, greater permanence is given by the application of a solution of gold.

The process as described by M. Fizeau, to whom we are indebted for its introduction, is as follows :—

"Dissolve eight grains of chloride of gold in sixteen ounces of water, and thirty-two grains of hyposulphite of soda in four ounces of water: pour the solution of gold into that of the soda, a little by little, agitating between each addition. The mixture, at first slightly yellow, becomes afterwards perfectly limpid. This liquid now contains a double hyposulphite of soda and gold.

"To use this salt of gold, the surface of the plate should be perfectly free from any foreign substance, especially dust; consequently it ought to be washed with some precautions, which might be neglected if it was to be finished by the ordinary mode of washing.

"The following manner generally succeeds the best: the plate being yet iodized, and perfectly free from grease on its two surfaces and sides, should have some drops of alcohol poured on the iodized surface; when the alcohol has wetted all the surface, plunge the plate into a basin of water, and after that into a solution of hyposulphite of soda.

"This solution ought to be changed for each experiment, and to consist of about one part of the salt to fifteen of the water: the rest of the washing is done in the ordinary way, only taking care that the water should be as free as possible from dust.

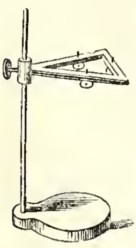

Fig. 34.

"The use of the alcohol is simply to make the water adhere perfectly all over the surface of the plate and prevent it from quitting the sides at each separate immersion, which would infallibly produce stains.

"When a picture has been washed, with these precautions, the treatment with the salt of gold is very simple. It is sufficient to place the plate on a support, fig. 34, or fig. 36, *g*, and pour upon its surface a sufficient quantity of the salt of gold that it may be entirely covered, and heat it with a strong spirit-lamp; the picture will be seen to brighten, and become in a minute or two of great force. When this effect is produced, the liquid should be poured off and the plate washed and dried.

"In this operation the silver is dissolved, and the gold precipitated upon the silver and mercury, but with very different results: in effect, the silver, which, by its reflection, forms the shades of the picture, is in some way darkened by the thin film of gold which covers it, from which results a strengthening of all the dark parts. The mercury, on the contrary, which, in the state of an infinite number of small globules, forms the lights, is augmented in its solidity and brightness by its union with the gold, from which results a great degree of permanency, and a remarkable increase in the lights of the picture."

The plates are then washed by means of an arrangement of this order. The apparatus represented in fig. 35 may be employed. *a* is a vessel sufficiently large to take the plate, and not more than half an inch wide: this is filled with distilled water, which is heated by means of a spirit-lamp; *b* is a stand supporting the trough, and *c* a holder for the plate. After the plate has been immersed for a few minutes, it is to be drawn out slowly, and by blowing on it the water is removed, and the warm metal rapidly dried. Such are the principal processes which have been adopted in the daguerreotype manipulation. Other modes for giving permanency to the Daguerrean image have been adopted, but none of them have been so thoroughly successful as those.

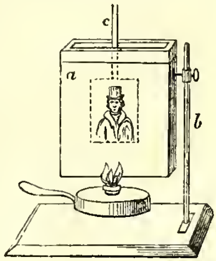

Fig. 35.

The apparatus for the Daguerreotype shown in fig. 36 may be enumerated with advantage.

a. Is the camera obscura, with the screen upon which the image is seen, and by which the focus is adjusted, partly raised; and when this is accurately determined a screw is shown by which it is secured.

b. Silver plate and edges for the same.

c c. Are bromide and iodine boxes of walnut, enclosing each a stout porcelain pan: each pan is furnished with an air-tight glass cover. On the upper edge of each box is a groove for holding the plate. On withdrawing the glass cover of the iodine pan, the plate is exposed to its action, and the colour produced is observed by holding a sheet of white paper in such a position that its reflection may be seen on the plate, which enables the operator to judge of the progress of the operation. When the plate has obtained the required colour, the glass cover is pushed in, so as to cover the iodine pan, and the cover over the bromine pan is withdrawn. The plate is now removed from the iodine box and placed over the bromine box, and the colour observed as before. When the plate has received the proper amount of bromine, which is perceptible by the colour, the cover of the bromine pan is pushed in, and the plate is again placed over the iodine pan for a few seconds, until the ultimate colour required is produced, and it is then ready for removal to the camera obscura.

d. Improved mercury box, of walnut, with sliding legs, iron cistern, glass windows for inspecting the development of the

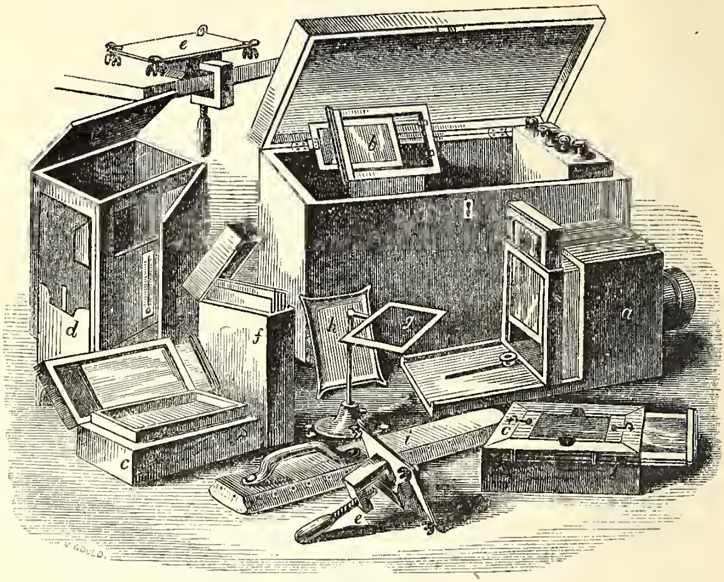

Fig. 36.

picture, mounted with thermometer for ascertaining the temperature of the mercury.

e e. Are plate holders, with clamp for securing the same.

f. Is a box for holding the Daguerreotype plates.

g. A levelling stand, used in the fixing process.

h. A flat peculiar dish for washing.

i. Is a hand-buff.

The pictures being completed, they are mounted in morocco or ornamented cases, such as are shown below.

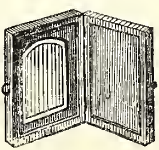

Fig. 37.

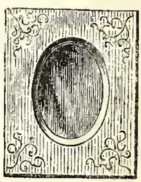

Fig. 38.

CHAPTER XI.

THE COLLODION PROCESS.

With the advance of this beautiful art, there has been a progressively increasing desire to produce more artistic results; to obtain these a medium more transparent than paper was necessary, and a surface more sensitive than the albuminized glass was required.

Collodion eventually presented itself to the photographer, and as the film on which to diffuse the photographic agents, it, beyond all other preparations, offers, in its exceeding sensibility, beauty of details in the finished pictures, and ease of operating, the most decided advantages.

Collodion is a peculiar preparation, formed by dissolving gun-cotton in ether containing a little alcohol. It is a mucilaginous solution of a volatile character, the ether evaporating and leaving a film of the utmost transparency behind. It is not all kinds of gun-cotton which dissolve equally well in ether. According to my experience the most easily soluble is prepared by soaking good cotton in a saturated solution of nitrate of potash for some time; it is then, in a moist state, plunged into sulphuric acid with which but a small quantity of nitric acid has been mixed: after remaining in the acid for about a minute, it is well washed with water until no trace of an acid taste is discovered, and then dried at a low temperature. There are no means of deciding to whom the use of collodion is due.

To Mr. Archer and Mr. Fry we are probably indebted for the introduction of this preparation as a photographic agent. The former gentleman, whose experience in the use of collodion renders him an authority upon the subject, has the following remarks:—

"There are two receipts for making gun-cotton, from either of which a good dissolving cotton may be obtained. Several others have been described, but I should only be confusing the subject to attempt to give the whole; and it would be foreign to the limited purpose of this work to do so. The results, however, vary so much with the strength and proportion of the acids used, as to render it extremely difficult to name any one in particular which would entirely succeed under all circumstances. In all cases it is more easy to prepare a cotton which will explode readily, and yet *not be at all soluble*, than one which will entirely dissolve in rectified sulphuric ether."

In the fourth edition Mr. Archer's formulæ were given. I believe, however, the following modifications will be found to be an improvement upon them :—

Take of dry nitrate of potash in powder, .	4 ounces.
Water, ...	3 drachms.
Pure sulphuric acid, . . .	5 fluid ounces.

Pour the proportion of sulphuric acid into the powdered nitre after the water has been added to that salt, stirring them well together for a few seconds with a long glass rod. Immediately the two are mixed add 70 grains of well selected cotton, having previously pulled asunder the fibres. Mix them well together with two glass rods, in order that the whole of the cotton may come in contact with the nitric acid which is being rapidly developed by the decomposition of the nitrate of potash. This action must be continued for about two minutes; then quickly remove the cotton with the adhering nitre and sulphuric acid from the basin, with the glass rods, and plunge it into a large quantity of water; it is to be well washed in repeated changes of water until all the acid and nitre are washed away. The cotton is then collected together, and first pressed between the hands to drain off the water, and then still further dried by pressure in a cloth; the fibres of the cotton can now be carefully separated, and hung up with pins to the edge of a shelf, or any other convenient place, to dry. There is no necessity to use artificial heat, as the small quantity requisite for a few ounces of solution can easily be dried in a warm room.

Certain proportions of nitric and sulphuric acids can be used instead of the above.

Take 1 oz. by measure of nitric acid, specific gravity 1·450.
1 oz. ,, sulphuric ditto, ordinary.
80 grs. by weight of cotton.

The fibres of cotton must be well separated, as in the preceding mode. The two acids are first mixed, and the cotton added as quickly as possible, and well stirred with two glass rods for not more than half a minute. The gun-cotton is removed from the acids, and plunged into water to undergo the same washings, &c., as in the former receipt.

It will be observed that the cotton is not exposed to the action of the mixed acids, in this last mode, longer than is necessary to saturate it; should the action be continued further, the solubility of the cotton is entirely lost.

Water must not be spared in washing the cotton, for no trace of acid should be left, as the collodion would be injured by any remaining.

Paper, flax, the pith of the elder, and numerous vegetable substances may be employed to prepare this peculiar chemical compound, to which the general term of Pyroxyline is applied. The following mode of preparing collodion with paper gives very constant results :—

6 fluid ounces pure sulphuric acid—specify gravity 1·845.
4 fluid ounces pure nitric acid ,, ,, 1·450.
1 fluid ounce of water.

Well mix these together in a wide-mouthed bottle, and then plunge into the mixture in strips

200 grains of filtering paper.

Let them stand for fifteen minutes, then wash with abundance of water and dry.

The substance *lignine*—which is the true wood of every variety of plant, and has the composition C 38, H 24, O 20—is capable of being converted into a material having an analogous constitution to true *gun-cotton*. With strong nitric acid *lignine* combines directly, and forms a substance called *xyloidine*. The composition of *xyloidine* is expressed by C 12, N 2, H 8, O 18. Starch dissolves by digestion in strong nitric acid, and on adding water *xyloidine* is precipitated. There are several other materials of which it may be prepared, and nearly all these substances are soluble in ether, forming *collodion*.

Gun-cotton is a compound of *lignine* with nitric acid—100 parts of cotton producing 170 parts of gun-cotton.

To Prepare the Collodion.—Fifteen grains of gun-cotton or paper, prepared as described, should be taken and placed in nine fluid ounces of rectified sulphuric ether, to which one ounce of alchohol, 60° over-proof, has been added. The cotton or paper, if properly made, will dissolve almost entirely ; any small fibres which may be floating about should be allowed to deposit, and the clear solution poured off previously to the process of iodizing it. Mr. Delamotte recommends the addition of a few drops of ammonia to the collodion, to prevent an acid reaction, which sometimes takes place. The plain uniodized collodion will keep in well-stoppered bottles for about three months ; but not much longer. We are not well acquainted with the changes which take place in the collodion ; but it certainly alters very much in its character, as is strikingly evidenced in the physical effects observable when it is used for photographic purposes.

To Iodize the Collodion.—Collodion may be iodized by several different methods—two or three of these will, however, suffice.

Prepare a saturated solution of iodide of potassium in alchohol by adding eighty grains of the iodide to a fluid ounce of the spirits of wine when it is nearly all dissolved, and add to it as much iodide of silver as it will take up, which will be less than thirty grains. Or to one ounce of alcohol add an excess both of iodide of potassium and iodide of silver; after a day or two, and with repeated shaking at intervals to facilitate the operation, a saturated solution of the two salts will be obtained, and if this is filtered off into another bottle it will always be found ready for use. The first bottle can be kept as a stock bottle, to obtain a still further supply by replenishing it with alcohol, and adding now and then small additional quantities of the two salts.

The iodide of silver can be readily obtained by precipitation. For instance, take one ounce of solution of nitrate of silver used in the process—thirty grains of nitrate of silver to one ounce of water,—and add to it sufficient of a solution of iodide of potassium in water to throw down the whole of the silver as an iodide. When this precipitated iodide of silver has settled, which it very readily does, the liquid above must be poured off, and fresh water added, repeating this washing several times. The iodide of silver after this is dried, and then put into a bottle with a small quantity of alcohol, just sufficient to keep it moistened. The quantity of this solution of the iodide of silver and iodide of potassium in the alcohol which can be added to one ounce of collodion, must depend upon the quantity of alcohol in the collodion. The experimental photographer is advised to try a series of simple experiments, and determine for himself the best proportion. He tries his first experiment with half-a-drachm or thirty minims of the alcoholic solution added to a fluid ounce of his collodion;—a second experiment, with fifty minims;—and so on, until he discovers for himself the best proportions for the collodion he uses. Iodized collodion is liable to decomposition, and iodine is liberated. This is prevented by putting a little piece of pure metallic silver in the collodion, which preserves it colourless and of a constant strength. Several practical photographers strongly recommend the iodide of ammonium in preference to the iodide of potassium.

The following answers well:—

Iodide of ammonium, . .	60 grains.
Alcohol, ...	2 fluid ounces.

Dissolve,—add of this one fluid drachm or sixty minims to one fluid ounce of plain collodion. This iodized collodion keeps much better than the former. The process now resolves itself into the following:—

Cleaning the Glass Plate.—A variety of substances, such as tripoli, nitric acid, spirits of wine, &c., have been recommended for cleaning the glass: but all these Mr. Horne—a good authority on this point—thinks quite superfluous; the only articles actually necessary being a clean cloth or two, and a wash leather that has been well and thoroughly rinsed through several changes of clean water, to deprive it as much as possible of the dressing which a new one contains, and a little liquid ammonia, not strong, but the ordinary *liquor ammoniæ* of the shops. If this is not at hand, a little caustic potash or soda will answer as well, the purport of it being to remove any greasy matter attached to the surface, as glass is frequently marked with soap; and although it might appear at first sight that clean water must thoroughly remove this, the operator will be certain of spoiling many of his pictures if he depend upon water alone.

Pour upon the plate a few drops of ammonia, rub it well over both surfaces, and thoroughly rinse in water, allowing the water to flow over the plate either by pouring from a vessel or holding it under a tap; now, with a clean cloth wipe perfectly dry, and finally well rub with a leather. Simple as this may appear, there is much more in it than will be at first imagined, for unless the glass is free from stains it is quite impossible to be successful. The plate may be washed perfectly clean, but the surface not thoroughly dried. Then, again, some hands are very warm, and if the plate is allowed to rest too much upon any one part, or held too long in the fingers at any one particular spot, that will become warmer than the surrounding part, from the glass being a bad conductor of heat. The cloth and leather should therefore be sufficiently large, that the plate may be as it were insulated as much as possible from the hands, that no unnecessary heat shall be applied. At the same time the employment of a warm cloth is very useful, for the heat is then equally diffused over the plate, and, what is very essential, the surface perfectly and quickly dried.

Coating the Plate.—It has already been pointed out how necessary it is to handle the plate as little as possible in cleaning; we therefore suppose the operator to have the plate in a clean dry leather, from which it is taken to receive the collodio-iodide of silver. The plate must be held by the left hand perfectly horizontal, and then with the right a sufficient quantity of iodized collodion should be poured into the centre, so as to diffuse itself equally over the surface. This should be done coolly and steadily, allowing it to flow to each corner in succession, taking care that the edges are all well covered. Then gently tilt the plate, that the superfluous fluid may return to the bottle from the opposite corner to that by which the plate is held. At this moment the plate should be brought into a vertical position, when the diagonal lines caused by the fluid running to the corner will fall one into the other and give a clear flat surface. To do this neatly and effectually, some little practice is necessary, as in most things; the operator should by no means hurry the operation, but do it systematically and quietly, at the same time not being longer over it than is actually necessary, for collodion being an ethereal compound evaporates very rapidly. Many operators waste their collodion by imagining it is necessary to perform this operation in great haste; but this is not the case, for an even coating can seldom be obtained if the fluid is poured on and off again too rapidly; it is better to do it steadily, and submit to a small loss from evaporation. If the collodion becomes too thick, thin it with the addition of a little fresh and good ether to that contained in the bottle.

Exciting the Plate.—Previous to the last operation it is necessary to have the bath ready, which is made as follows:—

Nitrate of silver, ...	30 grains.
Distilled water, ...	1 ounce.

Dissolve and filter. Some operators employ 40 grains of the silver salt.

The quantity of this fluid *necessary* to be made must depend upon the *form of trough to be used*, whether horizontal or vertical, and also upon the *size* of plate. The vertical trough is in my opinion the most convenient, though many still prefer the horizontal one, and attach a piece of India rubber to the back of the plate as a handle whilst applying the collodion, and to keep the fingers from the solution whilst dipping in the bath. With the vertical troughs a glass dipper is provided, upon which the plate rests, preventing the necessity of any handle, and rendering it unnecessary for the fingers to go into the liquid. If, however, the glass used is a little larger than is required, this is not necessary. Having then obtained one or other of these, filtered the liquid, and filled the bath, the plate coated with collodion is to be *immersed steadily and without hesitation*, for if a pause should be made at any part, a line is sure to be formed, which will print in a subsequent part of the process.

The plate being immersed in the solution, must be kept there a sufficient time for the liquid to act freely upon the surface, particularly if a negative picture is to be obtained. *As a general rule, it will take about two minutes, but this will vary with the temperature of the air at the time of operating, and the condition of the collodion.* In cold weather, or indeed anything below 50° Fahrenheit, the bath should be placed in a warm situation, or a proper decomposition is not obtained under a very long time. Above 60° the plate will be certain to have obtained its maximum of sensibility by two minutes' immersion, but below this temperature it is better to give it a little extra time.

To facilitate the action, let the temperature be what it may, the plate must be lifted out of the liquid two or three times, which assists in getting rid of the ether from the surface, for without this is thoroughly done, a uniform coating cannot be obtained; *but on no account should it be removed until the plate has been immersed about half a minute,* as marks are apt to be produced if removed earlier.

Having obtained the desired coating, the plate is then extremely sensitive, and, therefore, we presume the operator has taken every precaution to exclude ordinary daylight.

The room must be closed against any portion of daylight, and candle alone employed, placed at a distance from the operator to give the requisite light. Yellow glass, which has been recommended for glazing the operating room, does not furnish sufficient protection from the chemically active rays; with this very sensitive agent deep red glass answers much better.

The plate thus rendered sensitive must then be lifted from the solution and held over the trough, that as much liquid as possible may drain off previous to its being placed in the frame of the camera obscura, and the more effectually this is done the better; at the same time it must not be allowed to dry. The silver bath has been the subject of much inquiry, and should be the object of every degree of attention.

The bath already mentioned is the pure nitrate of silver bath, and it answers well when good nitrate of silver is obtained. Much of this salt contains adhering nitric acid, and it is a safe plan to add a grain of carbonate of soda to each hundred grains of nitrate of silver. This will render the solution milky from the formation of carbonate of silver, but filtration will make it clear again.

Acetate of silver has been recommended by many photographers as an addition to the nitrate of silver bath for *negative* images; it certainly appears to yield a darker image, but its operation is not understood.

A little of the washed iodide of silver (one grain to sixty of the nitrate of silver) added to the bath, with a few drops of alcohol, gives a satisfactory result.

The question is often asked, how soon after coating the plate with iodized collodion should it be immersed in the nitrate bath? Now, this is a difficult question to answer. We have said the time of *immersion* is dependent upon the temperature and quality of the collodion; so likewise must we be governed as to time *before immersion.*

To obtain a Picture.—The next question, also often asked, is, how long must be the exposure in the camera obscura? a question more difficult to answer than the last, without knowing the character of the lens and the intensity of sunshine. Practice alone can determine this, combined with close observation of those parts which should be the shadows of a picture. If, for instance, in developing we find that those parts less exposed to the light than others develop immediately the solution is applied, then we have reason to suppose the exposure has been too long; but if, on the contrary, they develop very slowly, we have proof the time allowed has not been sufficient to produce the necessary action. In a good picture we should see first the whites of a dress appear, then the forehead, after which we shall find, if the light has been pretty equally diffused, the whole of the face, and then the dress.

The author of this volume is constantly receiving letters requiring exact information as to the time necessary for the exposure of the collodion plate in the camera obscura. This question, cannot be replied to—to-day one second may suffice—to-morrow half a minute may not be long enough; one photographer may prepare his plate in such a manner that even in a few seconds his negative picture is too dark, another may find that he cannot obtain a negative picture dark enough in several minutes. Experiment alone can determine for each individual the duration of exposure for his sensitive plate in the camera obscura.

The Development of the Image.—To effect this the plate must be taken again into the dark room, and with care removed from the camera obscura to the levelling stand.

It will be well to caution the operator respecting the removal of the plate. Glass, as before observed, is a bad conductor of heat; therefore, if in taking it out we allow it to rest on the fingers at any one spot too long, that portion will be warmed through to the face; and as this is not done until the developing solution is ready to go over, the action will be more energetic at those parts than at others, and consequently destroy the evenness of the picture. We should, therefore, handle the plate with care, and it is advisable to get it on the stand as soon as possible.

Having placed it there, we must next cover the sensitive surface with the developing solution.

This should be made as follows:—

Pyrogallic acid, ...	5 grains.
Distilled water, ...	10 oz.
Glacial acetic acid, ...	40 minims.

Dissolve and filter.

Mr. Delamotte employs

Pyrogallic acid, ...	9 grains.
Glacial acetic acid, ...	2 drachms.
Distilled water, ...	3 ounces.

Mr. Hennah recommends

Pyrogallic acid, ...	1 grain.
Glacial acetic acid, ...	5 minims.
Alcohol, ...	10 minims.
Distilled water, ...	1 fluid ounce.

In developing a plate, the quantity of liquid taken must be in proportion to its size. A plate measuring five inches by four will require half an ounce; less may be used, but it is at the risk of stains; therefore it is recommended that half an ounce of the above be measured out into *a perfectly clean measure*, and to this from eight to twelve drops of a fifty grain solution of nitrate of silver added.

Pour this quickly over the surface, taking care not to hold the measure too high, and not to pour all at one spot, but having taken the measure properly in the fingers, begin at one end, and carry the hand forward; immediately blow upon the face of the plate, which has the effect not only of diffusing it over the surface, but causes the solution to combine more equally with the damp surface of the plate: it also has the effect of keeping any deposit that may form in motion, which, if allowed to settle, causes the picture to come out mottled. A piece of white paper may now be held under the plate, to observe the development of the picture; if the light of the room is adapted for viewing it in this manner. If not, a light must be held below, but in either case arrangements should be made to view the plate easily whilst under this operation, a successful result depending so much upon obtaining sufficient development without carrying it too far.

As soon as the necessary development has been obtained, the liquor must be poured off, and the surface washed with a little water, which is easily done by holding the plate over a dish and pouring water on it, taking care, both in this and a subsequent part of the process, to hold the plate horizontally, and not vertically, so as to prevent the coating being torn by the force and weight of the water.

Protosulphate of iron, which the author first introduced as a photographic agent in 1840, may be employed instead of the pyrogallic acid with much advantage. The beautiful collodion portraits obtained by Mr. Tunny of Edinburgh, are all developed by the iron salt. The following are the best proportions:—

Protosulphate of iron, ...	1 oz.
Acetic acid, ...	12 minims.
Distilled water, ...	1 pint.

This is to be used in the same manner as the other solutions.

Fixing of Image.—This is simply the removal of iodide of silver from the surface of the plate, and is effected by pouring over it, after washing with water, a solution of hyposulphite of soda, made of the strength of four ounces to a pint of water. At this point daylight may be admitted into the room; and, indeed, we cannot judge well of the fixing without it. We then see, by tilting the plate to and fro, the iodide gradually dissolve away, and the different parts left more or less transparent, according to the action of light upon them.

It then only remains to thoroughly wash away every trace of the hyposulphite of soda, for, should any of the salt be left, it gradually destroys the picture. The plate should, therefore, either be immersed with great care in a vessel of clean water, or, what is better, water poured gently and carefully over the surface.

After this it must be placed upright to dry, or held before a fire.

Nothing now remains but to preserve the picture, which we have obtained, and secure it for the purpose of printing positive pictures. A transparent spirit varnish should be used for this purpose. The plate must be made warm by placing it on a stove, or a hot plate, and then the varnish (mastic, amber, or copal), must be poured steadily over it, and when the surface is covered, placed so that all the superfluous quantity may run off in the bottle containing it. It soon dries and this operation is completed.

It is with much satisfation that we give our readers the advantage of the experience in manipulation of Mr. Kibble of Glasgow, who has obligingly given the following detailed account of his mode of manipulating for producing positive pictures :—

Preparation of the Soluble Paper.—Take of sulphuric and nitrous acids equal parts, by volume, and as soon as convenient after mixing the same, add thereto Swedish filtering paper: cut into strips, holding the same by one end, lower the first fold on to the surface of the mixed acids, and immediately, with a glass rod press the folds in succession under the surface, being careful that no one of them touches the other until fairly covered with the fluid, otherwise they will adhere. The time required for converting the single fold of paper into a soluble state being insufficient for these adhering, will give trouble afterwards. Let the piece last immersed be a small bit with the end projecting from the receiver so that at the expiration of fifteen minutes you can, with the finger and thumb, withdraw it from the fluid and plunge it into abundance of clean water: after moving it about for a little commence to draw the strips between the thumb and fingers of the opposite hand so as thoroughly to expunge all the acid therefrom, which you can test by the mouth; if tasteless, use blotting-paper, and then dry before the fire. Now test its solubility in five parts of ether with three parts of alcohol (by volume), after a few minutes it should become quite transparent, retaining its shape until it becomes so thin that it gradually falls to the bottom as a clear pulp. Should this take place you may at once remove the whole of the paper from the acid, and leave it in a large quantity of clean water to steep, changing pretty often at first, finishing as in the first instance by drawing all the strips individually between the thumb and fingers in a new quantity of water until tasteless, there being no haste now. After blotting, the whole may be left to dry spontaneously. Preparation of the collodion.

Ether, 5 parts } by vol.
Alcohol, 3 parts }

To each fluid ounce of the alcoholized ether add about eight grains of the above prepared soluble paper, which, on arriving at the transparent point already indicated should be shaken for a little, then left at rest for half an hour, then again shaken and left to settle. The quantity of paper named is much more than will dissolve, but this advantage is gained that only the highly soluble portions enter into solution; and decanted from the deposit and thinned down by the addition of alcoholized ether to suit the wish of the operator, a beautiful limpid collodion will be obtained. To iodize the collodion employ:—

5 grs. iodide of cadmium }
1 gr. do. of potassium } to the fluid ounce of collodion.
$\frac{1}{2}$ gr. bromide of ,, }

To Clean the Glasses.—When this has to be done for the first time, use cyanide of potassium, a saturated solution, reduced by adding thereto one vol. water, which will at once remove everything of a greasy nature. Wash well in clean water, then use nitric acid as strong as your cloth will stand, and conclude by employing plenty of clean water. On putting aside the plates to drain before finally drying them, be cautious not to allow them to touch or rest on a table or board that has been in contact with any chemicals, however clean you may think you have made the same. Have a stand for the purpose, and always put plenty of clean blotting-paper to absorb the moisture as it leaves them, and conclude by drying them with a cloth which has been well washed with caustic potash and water, and finally in clean water. You cannot be too particular in this operation.

Coating of the Glasses.—Never have the bottle from which you intend to pour the collodion on to the glasses more than half full, so that you can lower the mouth of the same within quarter of an inch of the plate, before the liquid begins to flow; by this you avoid spheroidal drops, which are a great detriment as they immediately set and the flood of collodion passes over them; some are partially dissolved, others adhere, giving the glass a double coating at those particular points. Be sure and receive the superfluity, poured from the plate, into a bottle ready for the purpose. By this arrangement the collodion you coat with is kept almost of a uniform quality, and free from the dust that would otherwise be washed back into it. None but those who have carefully examined into the evils are aware of the great annoyance caused by dust, which, with every precaution, will keep falling on the plate. Pour on abundance of the collodion so that the slightest movement of the hand will cause it flood in any desired direction. As soon as the plate is covered, gradually lower one corner until the collodion commences to flow, then you may boldly and quickly tilt it, almost vertical to the mouth of the bottle, and as soon as it ceases to drop rapidly bring it almost level, the dropping end being the lowest, and with the forefinger of the right hand blot off about half an inch of the corner, as, if put into the silver bath very moist or thick, it is sure to leave the plate at that particular part. There are other precautions I would suggest to those using large plates which require to be balanced on some support, viz., to allow them when setting after being coated to remain as short a time as consistently can be done in contact with the rest or support, as the rapid evaporation of the ether lowers the temperature of the glass, which in turn abstracts heat from the points in contact with it, thereby causing the collodion to set quicker at those parts, leaving an impression in all the subsequent operations which is highly mortifying. This will be easily understood by those who have commenced by balancing their plates on their thumb and fingers, even though covered by non-conductors of heat. The collodion in the receiving-bottle after it has accumulated can be thinned down by the addition of alcoholized ether and set aside to deposit dust, &c., and will be as good as formerly or nearly so.

To prepare the silver or sensitive solution:—

30 grains nitrate silver.
1 grain iodine.
1 ounce water, distilled.

Put these proportions into a glass or porcelain receiver and boil for about ten minutes or quarter of an hour, then allow to cool, a large quantity of the iodide of silver added will have been taken up at the boiling point; but on cooling a quantity is deposited as a double salt of nitrate and iodide of silver; this disables the bath from attracting the iodide of silver formed upon the plates rendered sensitive therein, and has this additional benefit, that should any obstacle occur to prevent the exposure of your plate after the same has been excited, you may leave it in the silver bath for hours; indeed, I have exposed plates prepared the evening previous, on the next day, with very satisfactory results. Those using gutta percha baths sometimes find annoyance after the silver solution has been in the same for a few days; this is caused by an oil which is acted on by the silver for the first few days, and falls as a sludgy deposit; if filtration does not cure the same, re-boiling and filtration of the solution is sure to do it. With regard to after alterations, which take place in the bath, such as acidity, alkalinity, it is best to leave that to the experience of the operator, so much depends on the qualities of the collodion; rules that may suit one will be certain of failure with another, there being often so many latent modifying causes. Into the above prepared bath lower your collodion plate by a steady uniform movement, immediately it sets a little, which a short experience with any collodion will determine. Should any interruption cause a stoppage of the plate in its descent, you may withdraw it at once, as it will most certainly be spoiled, having a clear line cut across the film parallel to the fluid. After the plate has been immersed ten or fifteen seconds it may be raised with advantage once or twice for a second or two to facilitate the escape of the ether. After about two minutes' immersion, the greasy looking lines formed by the ether escaping from the film will have ceased, the plate may then be withdrawn, and will develop evenly (unless otherwise influenced), but, as already mentioned, with the bath prepared according to the above instructions, it can wait the convenience of the operator.

Those who use vertical baths and keep the same always charged, although with a lid covering to protect the solution from dust, would do well each day before commencing operations to skim the surface with a piece of paper, or lower a clean uncoated plate into the silver, which will thoroughly abstract the dust, otherwise they will often find their first picture develop with something of the appearance of marbled paper. This is an evil I have often met with in floating paper in various solutions where I have been pressed for time and neglected this precaution, so often, indeed, that I now make it a rule never to operate unless I have time to put the solutions in working condition. After exposure of the plate in the camera—which, with a three or four inch diameter landscape lens, of twelve or fourteen inches focal distance, will vary in summer from five seconds to one minute exposure, according to the actinism of the day—you subject the latent picture to the following developer:—

Proto-sulphate of iron, ...	15 grains.
Water, ...	1 oz.
Nitrate of potash, ...	7½ oz.
Nitrate of acid, ...	3 drops.
Acetic acid, about one-tenth of the bulk of water.	

This developer is a mixture of proto-nitrate and proto-sulphate of iron, which I find to give very good results, and it will keep good for a fortnight, but after that time I would advise a new quantity, or the addition of a little more of the sulphate iron and nitrate potash, as the solutions of iron commence to peroxidize from the time they are mixed, hence they lose their power of deoxidizing or reducing the silver which forms the picture. Should the plates be small, say six by four inches, they may be developed easily and regularly by pouring on the developer, but if longer, a flat porcelain developing dish is preferable, and this allows you to see distinctly the image coming out with a very faint light. Immediately you rest the end of the exposed plate in the developer, that instant commence to lower it, otherwise you will get a dirty looking deposit of metallic silver which will be spread over a considerable portion of the picture. A picture which has been exposed for too short a time will be easily known by the slowness with which it makes its appearance; also by small spangles of silver similar to what you will always find deposited in a developing bath which has been used, adhering to the pictures. This is easily accounted for. Solutions of protosalts of iron, when mixed with nitrate of silver, after a few seconds commence to decompose it by virtue of its affinity for oxygen; this it takes from the nitrate, reducing it to the metallic state, and in turn becoming a persalt of iron. This is a purely chemical action, so that when the photogenic action is slow the chemical outstrips it and does the evil mentioned. So soon as the picture seems fairly developed, which a little practice will tell, immediately pour water gently upon it or lower it into a receiver of water to stop any further action, or the chemical action will commence its deposit and destroy the picture. Nothing further is required, but after washing the plate free of adhering iron to lower it into the following solution:—

To fix the Picture.—

Cyanide potassium, 1 oz. to a pint of clean water.

Nitrate of silver, 40 grs. dissolved in an ounce of water and mixed. You will soon find whether or not your picture has been washed free of iron, if not, you will find clouds of blue all over it, which is caused by free hydrocyanic acid acting on the iron, forming a Prussian blue. When the picture becomes transparent in the shadows it may be removed from the bath and washed, the iodide being now completely removed it is safe to let it steep a few minutes in water before putting aside to dry, after which it can be backed with the usual solution of asphaltum in naphtha.

Such is the process of Mr. Kibble, who has produced numerous admirable pictures by this mode of manipulation.

CHAPTER XII.

THE PRESERVATION OF SENSITIVE COLLODION PLATES.

By the processes described we produce photographic plates of extreme sensibility, but unfortunately that delicacy of the chemical adjustment, which is the cause of the rapidity with which an impression is received, soon passes away upon the drying or consolidation of the collodion film.

Several operators have turned their attention to this subject. It soon became evident that if it was possible to preserve the collodion from drying, the plate might be kept in a sensitive state for some time. Many methods have been adopted to secure this end; from those which have been published the following are selected as being by far the most satisfactory:—

Nitrate of Magnesia Process.—Various deliquescent salts suggested themselves to, and were employed by Messrs. Spiller and Crookes, and all of them with a certain degree of success. The most favourable results were obtained with nitrate of magnesia, which is employed in the following way:—

The plate coated with collodion in the usual manner is rendered sensitive in a thirty grain nitrate of silver bath, in which it should remain rather longer than is considered necessary (about five minutes), it must then be slightly drained and immersed in a second bath consisting of—

Nitrate of magnesia, ...	4 ounces.
Nitrate of silver, ...	12 grains.
Glacial acetic acid, ...	1 drachm.
Water, ...	12 ounces.

and there left for about five minutes, then removed and placed in a vertical position on blotting-paper, until all the surface moisture has drained off and been absorbed, this generally takes about half an hour. The plates thus prepared may be packed in any convenient box until required for use. Messrs. Spiller & Crookes assure us that they have kept the plates thus prepared upwards of three weeks, and there has been no appearance of deterioration in them. Before development they find it advisable to moisten the collodion film by immersion in the silver bath for about half a minute, as otherwise the pyrogallic acid or the iron solution does not flow evenly over the plate.

Glycerine Process.—Those photographers, Mr. Pollock and some others, have been employing *glycerine* with much advantage. The best mode of using it appears to be the following:—

The cleaned glass plate is coated with iodide of ammonium collodion in the usual way and immersed in the thirty grain nitrate of silver bath, which has been fully saturated with iodide of silver, so that the plate may be left its full time without fear of dissolving the sensitive film. After remaining for three or four minutes the excited plate is transferred to and immersed for an equal time in a washing bath of pure distilled water; or instead of this bath a stream of water from a syringe bottle may be employed, the object being to remove the excess of free nitrate of silver from the sensitive film. So prepared the plate is ready for the glycerine. An intimate mixture is made of three parts by volume of Pryce's glycerine, specific gravity 1·23, and one part of this silver solution (one grain of nitrate of silver and thirty minims of glacial acetic acid to the ounce of water—with a trace—less than a drop, of nitric acid). This mixture is poured on the surface of the washed collodion plate, its action being assisted by transferring some two or three times to and from the measure glass. After five minutes' contact the plate has to be well drained and placed in nearly a vertical position on blotting-paper, which will absorb the large excess of glycerine from its surface. The plate is then ready for the camera, and it may be preserved full twenty days without any loss of sensibility. Before proceeding to develop the latent image on the glycerine plate, it is only necessary to immerse it for two or three minutes in the thirty grain nitrate of silver bath, when the solution of pyrogallic acid or protosalt of iron may be applied as usual.

Honey Process.—Mr. Shadbolt states that he has used loaf sugar, moist sugar, grape sugar, sugar of milk, mannite and honey, for the purpose of preserving the collodion plates, and that honey has proved the best preservative agent.

The preservative syrup is made with three volumes of pure honey and five volumes of distilled water. This mixture is stirred with a glass rod until the honey is thoroughly dissolved, and then filtered through blotting-paper (a process occupying some hours), and to the filtered solution one volume of alcohol is added. Immediately after the plate is rendered sensitive in the ordinary way, the syrup is poured over it so as to cover it. Do this with the same portion of syrup three times and then place the plate to drain. In about ten minutes the plates may be placed in a dark box and preserved for use. Pictures have been taken on plates thus prepared three weeks after excitation.

Before developing, the following practice has been recommended by Mr. Shadbolt :—"I first of all plunge the plate with its latent picture into a bath of distilled water for from five to ten minutes, lifting it up and down occasionally, the exact time is not important, the object being to moisten the collodion evenly, and at the same time get rid of most of the preservative syrup. I then remove it, drain off closely the superfluous water, and plunge the plate for a single instant into the nitrate bath, remove it immediately, and drain a few drops from the plate into a glass measure; then add the pyrogallic acid solution to the liquid drained from the plate and develop in the usual manner. The developing solution I make as follows:—

Pyrogallic acid, ...	8 grains.
Distilled water, ...	5 fluid ounces.
Acetic acid (not glacial), . .	2 fluid ounces.
Alcohol, ...	1 ounce.

The acetic acid I use is the ordinary acid of the shops, and costs from 8d. to 1s. per pound. The plate is then washed and fixed in the usual manner."

Oxymel Process.—This process introduced by Mr. Llewellyn is a modification of the honey process already given. This gentleman says, "My method of proceeding, is to prepare the collodion plate in the usual way, and when taken from the nitrate bath to immerse it in water in a gutta percha tray for two or three minutes; pour away this first water, and wash again with a fresh supply, so as thoroughly to remove all traces of free nitrate of silver. On removal from this second washing bath, drain pretty closely, and immerse again in a filtered bath composed of one part of oxymel to four parts of water. This preservative solution should be placed in a horizontal gutta percha tray similar to that used for the water bath: it should be tilted at one end—the plate, collodion side upwards, is to be placed in this; and when the tray is restored to its level, the syrup will run with an even wave over the sensitive film, and may remain covering it for about a minute; then tilt the tray again, raise the plate evenly, and place it to drain on a piece of clean blotting-paper, which should be renewed after the lapse of a few minutes. To develop, it is necessary to wash the plate in water for four or five minutes, and then pour on pyrogallic acid of the usual strength, and in the usual manner, adding previously two or three drops of the silver bath. Mr. Llewellyn—than whom few gentlemen have practised Photography more zealously or successfully—says, "I can recommend it —the oxymel process—with great confidence as the best method among the many that I have tried; and indeed, I find it fulfils all the conditions which are required for field work in the production of photographic landscapes, when at a distance from the laboratory or the tent."

Albuminized Collodion.—M. Taupenot having employed albumen as a varnish to preserve the collodion plate, arrived at a process which enabled him, with dry plates, to obtain all that we can get with moist and recently prepared collodion. His process is:—having collodionized the plate, dipped it in the silver bath, and washed it with distilled water, pour on it albumen iodized in the proportion of one and a-half per cent., either fresh or old; then let it drain and dry. The plate may be preserved in this state for several days. When about to be used, it must be dipped in the bath of aceto-nitrate (ten parts of nitrate of silver, and ten parts of acetic acid, to 100 parts of distilled water), the plate must be left in this bath for ten or twenty seconds, and the bath should be carefully filtered at the moment of using it, especially if pyrogallic acid is to be used subsequently for the development of the image. The plate is then washed in distilled water, and may be used immediately while still moist, or kept in a sensitive state.

Dr. Taupenot prepares his albumen in the following manner:—ten parts of honey are mixed with 100 parts of albumen; a little yeast is added, and one part and a-half of iodide of potassium. This is allowed to ferment; after fermentation the liquid must be filtered and stored in bottles, containing only from three to six fluid ounces; in this way provision may be made for a year or more.*

Barnes's Dry Collodion.—Mr. Barnes employs the following iodized collodion:—

Plain collodion, ...	4 ounces.
Solution of iodide of potassium, . .	5 drachms.
Pyroacetic spirit purified, . . .	4 drachms.
Camphor, ...	4 grains.
Etherial tincture of chloride of gold, .	10 drops.
Tincture of iodine, ...	½ drachm.

The ingredients having been added to the plain collodion; and when the camphor has dissolved, the whole should be allowed to settle. A small quantity of old collodion, one ounce of old to four ounces of new is to be added to the mixture—this gives it greater firmness. (Old collodion is decolourized in the following manner:—to sixteen ounces of old collodion, add one ounce of anhydrous carbonate of soda, and about four drachms of acetic naphtha; shake the mixture occasionally until decolourized, which will take place in about a couple of days.)

* While these pages are passing through the press, improvements in Taupenot's process are made, which will appear in the APPENDIX.

The glass plate having been carefully cleaned, the collodion is applied in the usual way, and then dipped in a silver bath saturated with iodide of silver. Mr. Barnes adds alchohol to his bath, which appears objectionable. The plate being immersed, is washed with distilled water, and dried spontaneously, standing upon bibulous paper, or placed in the drying box, fig. 39.

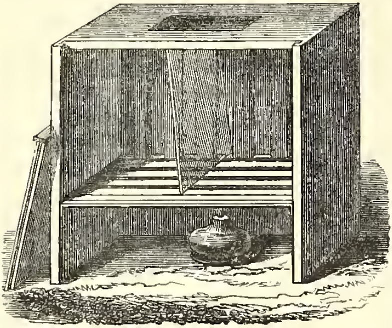

Fig. 39.

This scarcely requires any description. The bottom is formed of slips of wood, beneath which is an iron plate, upon which the flame of the spirit-lamp plays; at the top of the box an aperture must be made, to allow the moisture to escape; this is covered, when in use, with a piece of fine muslin. The plates, when dry, are preserved in the plate box, and they are said to be, at the end of six weeks, as rapid in their action as at first.

When the plate is removed from the camera obscura, it must be immersed for about a minute in the washing bath, and afterwards placed on the levelling stand, and flooded with the following solution :—

Saturated solution of gallic acid, . .	4 ounces.
Distilled water, ...	4 ounces.
Acetic acid, ...	1 drachm.
Pyrogallic acid, ...	4 grains.
30 grain solution of nitrate of silver, .	10 drops.

We have seen many beautiful pictures produced by this process, and from report it appears, when proper care is used, to answer.

CHAPTER XIII.

MODIFIED FORMS OF THE COLLODION PROCESS.

Positive Images.—It was shown at a very early period that the collodion picture might be rendered either negative or positive, by slight variations in the manipulatory details. Positive pictures on collodion plates offer such numerous facilities that they have become especial favourites. This is to be regretted, for, although good operators may produce pleasing pictures, bad ones are content, if they obtain images which are slightly removed from the blackness of the necessary backing.

For positive pictures the same bath and the same collodion, —for which receipts have already been given—answers, but both may be very considerably diminished in strength, and yet yield good results.

It was shown by Mr. Horne in the early days of collodion, that the negative images could be converted into positive ones by mixing with the pyrogallic acid solution a very small quantity of nitric acid; but it has since been proved by Mr. Fry, and others, that a better result may be obtained by the use of proto-sulphate and proto-nitrate of iron.

The former salt is readily obtained, and in a very pure form. It should be used as follows:—

Proto-sulphate of iron, . . .	10 grains.
Distilled water, ...	1 oz.
Nitric acid, ...	2 drops.

To develop the image pour the above over the plate, taking care not to carry the development too far.

The proto-nitrate may be obtained by double decomposition, in the following manner, as recommended by Dr. Diamond: 600 grains of proto-sulphate of iron are dissolved in one ounce of water, and the same quantity of nitrate of baryta in six ounces of water; these being mixed together, proto-nitrate of iron and sulphate of baryta are formed by double decomposition. Mr. Ellis, however, proceeds as follows:—

To one ounce of nitric acid and seven of water, add a small quantity of sulphuret of iron broken into fragments. Place the vessel aside, that the sulphuretted hydrogen may escape, and the acid become saturated with iron. Pour off the liquid, and filter. Then boil in a Florence flask, to get rid of the sulphur, and again filter, when a dark green liquid will be obtained, which is the proto-nitrate of iron. This should be kept in well-stopped bottles, and protected from the air as much as possible, to prevent its changing into a pernitrate, in which state it is quite useless as a photographic agent.

To develop the picture mix one part of the above proto-nitrate with three of water, and apply it to the plate in the ordinary way, when a most beautiful clear image will be obtained.

The negative image being developed, a mixture of pyrogallic acid and hyposulphite of soda, which has undergone partial decomposition, is poured over the plate, and then it is gently warmed. Upon this the darkened parts are rendered brilliantly white by the formation of metallic silver. This picture being backed up with black velvet assumes the air of a fine Daguerreotype, without any of the disadvantages arising from the reflection of light from the polished silver surface. Photography is indebted to Dr. Diamond, who is still pursuing the subject with much zeal, for improvements in the process of obtaining positive collodion pictures. Mr. Fry and Mr. Berger, by the use of the proto-sulphate of iron solution and pyrogallic acid, have obtained pictures of great beauty. The image is first developed by the iron and the solution poured off: immediately the pyrogallic aeid is poured on, and the effect is produced.

Mr. Hennah has the following remarks on the production of positives by himself:—

Collodion rather thinner than usual is employed, the plate is excited with the ordinary bath, and after exposing not more than half the time that would be required for a negative, the image is brought out by immersing it in a bath made as follows:—

Proto-sulphate of iron, ...	40 grains.
Nitric acid, ...	2 drops.
Acetic acid, ...	30 minims.
Alcohol, ...	20 minims.
Distilled water, ...	1 ounce.

The pictures are fixed with the hyposulphite of soda in the usual method.

A peculiar whitening process was introduced by Mr. Areher, which is as follows:—

The picture being thoroughly washed in plenty of water, after fixing with hyposulphite of soda, is treated in the following manner:—

Prepare a saturated solution of bichloride of mercury in muriatic acid. Add one part of this solution to six of water. Pour a small quantity of it over the picture at one corner, and allow it to run evenly over the glass. It will be found immediately to deepen the tones of the picture considerably, and the positive image will almost disappear; presently, a peculiar whitening will come over it, and in a short time a beautifully delicate white picture will be brought out.

The negative character of the drawing will be entirely destroyed, the white positive alone remaining. This picture, after being well washed and dried, can be varnished and preserved as a positive; but nevertheless, even after this bleaching, it can be changed into a deep-toned negative, many shades darker than it was originally, by immersing it, after a thorough washing, in a weak solution of hyposulphite of soda, or a weak solution of ammonia. The white picture will vanish, and a black negative will be the result.

It is very singular that the picture can be alternately changed from a white positive to a black negative many times in succession, and very often with improvement.

In the first part of this after-process, it will be observed that the effect of this bichloride of mercury solution is to deepen the shades of the picture, and this peculiarity can be made available to strengthen a faint image, by taking the precaution of using the solution weaker, in order that the first change may be completed before the whitening effect comes on.

The progress of the change can be stopped at this point by the simple application of water.

The author first pointed out the remarkable action of corrosive sublimate, in his paper, published by the Royal Society, on the Daguerreotype process on paper.

Variations in Manipulation.—M. Adolphe Martin has published some remarks on the collodion in the *Comptes Rendus* of 5th July, 1852, which are worthy attention.

The collodion he employs is made of gun-cotton thus prepared:—

30 grains of cotton.
750 grains of nitrate of potash.
1,500 grains of sulphuric acid.

This is well washed and dissolved in 10 volumes of ether, and 1 volume of alcohol: by this, 15 grains of gun-cotton are dissolved in 1,860 grains of ether, and 930 grains of alcohol: add then to this collodion, 15 grains of nitrate of silver transformed into iodide, and dissolved in 20 grains of alcohol by means of an alkaline iodide. M. Adolphe Martin prefers iodide of ammonium.

The plate is next plunged into a bath of 1 part distilled water,

$1\frac{1}{12}$ nitrate of silver, and $1\frac{1}{20}$ nitric acid. The image is developed by the proto-sulphate of iron, and is changed from negative to positive by a bath of double cyanide of silver and potash consisting of 2 quarts of water, in which are dissolved 375 grains of cyanide of potassium, and 60 grains of nitrate of silver.

It has been proposed to use the bromide, instead of iodide of silver, in collodion.

The most successful operator with the bromodized collodion appears to have been M. Laborde, who communicated the following as the results of his practice to *La Lumiere*, French photographic journal :—

"I have studied the action of bromides by themselves and in combination with collodion. My choice naturally fell upon those soluble in alcohol or ether, and I have tried the bromides of iron, nickel, cadmium, zinc, and mercury. The bromides of iron, nickel, and cadmium yielded the best results, and among these I give the preference to the bromide of cadmium. I have found it to possess so many advantages, that I have been several times tempted to banish all iodides from my preparations Fifteen grains of bromide of cadmium, added to 1½ ounce (by weight) of solution of collodion, gives a liquid which may be used at once, and which has been kept for about five months, up to the present time, without perceptible change. Sulphate of iron, or pyrogallic acid, are used for developing; gallic acid produces but a very middling effect; almost all the details of the image appear at once, the effect of the weakest radiations become sensible; but the extreme tints of the proof are not sufficiently different to allow of being printed from with success. The following process is made use of to give them an actual value in this respect.

"By adding a weak proportion of iodide of potassium to the bromide of cadmium the sensibility is increased, and we obtain at the same time a greater difference between the extreme tints of the proof; the negatives are therefore superior. The following are the proportions usually employed :—

Bromide of cadmium, ...	12 grains.
Iodide of potassium, ...	0·3 grains.
Collodion, ...	1½ ounce.

"At first the iodide of potassium tinges the collodion with yellowish-red, but the bromide of cadmium by degrees removes this tint, and the solution becomes colourless."

Mr. W. Crookes has been investigating the action of the bromides with a zeal and accuracy from which we may expect some important results. The following communication, made by him to the Photographic Society of London, will be read with interest :—

"I have for some time past been working with bromized collodion, and as, from my experience, it seems likely to become an agent of great value, perhaps the following account of some experiments with it may prove of interest to any photographer, who has the time and means at his disposal to investigate the subject more fully in its practical application.

"To prepare the collodion I proceed as follows:—Mix together equal bulks of sulphuric acid, specific gravity 1·80, and nitric acid, specific gravity 1·50; stir well with a glass rod, and then, while still warm, immerse as many pieces of good Swedish filtering-paper as the vessel will conveniently hold. Allow them to remain together for one hour; then pour the liquid away, and wash the paper until free from the slightest trace of acid, and allow it to dry in a warm room.

"Take eight drachms of the purest washed ether and ½ drachm of spirits of wine, 60° above proof, and dissolve in this six grains of the above prepared paper. This collodion may be bromized in the following manner:—In a small bottle place about two grains of crystallized nitrate of silver and about ten grains of pure bromide of ammonium; pour on this two drachms of spirit 60° above proof, and allow them to remain together for some hours, shaking the mixture several times. One drachm and a-half of the supernatant liquid are to be added to every ounce of the previously prepared collodion. Thus bromized, it will remain perfectly colourless and good for a long time.

"I excite the plate in a thirty grain silver bath, which has been previously saturated with bromide of silver; about two minutes' stay in this bath is generally sufficient, though a little longer time does not injure it. The film of bromide of silver is a pale orange by transmitted and blue by reflected light, and is very transparent. For developing, I prefer proto-nitrate of iron, being more accustomed to it, but have no doubt that in other hands pyrogallic acid would answer equally well. The above proportions of paper, alcohol, and bromizing compound may be varied within certain limits without much influencing the result. I have given the proportions which I am most in the habit of using, but would recommend that the experimentalist should ascertain for himself whether a slight departure from the above proportions would give a collodion of the consistency and strength of that with which he is most accustomed to manipulate.

"The chief advantages it seems to possess over the ordinary iodized collodion, besides its great sensitiveness, are the following. In a landscape the required opacity of the more strongly illuminated parts (the sky, for instance) is not lost by over-exposure; vegetation is also more easily copied. Its superior sensitiveness to coloured light is, however, most strikingly shown when coloured glass or sulphate of quinine (as suggested by Sir John Herschel) is employed to absorb the strongly acting invisible rays. To prove this, I arranged several flowers and plants with a view to obtain a great contrast of colour, light, and shade. The best picture I could obtain of them on iodized collodion was, as I had anticipated, wanting in half-tint, very few of the colours producing an adequate impression. When, however, bromized collodion was used under the same circumstances, but with the interposition of the bath of sulphate of quinine, every part came out with nearly the same gradation and depth of light and shade as existed in nature: this picture on bromized collodion behind the quinine bath required 40 minutes; on iodized, without the quinine solution, 4 minutes; but when I attempted to take a photograph on iodized collodion, with the quinine bath interposed, I found that with the light I was working in, the plate would not keep a sufficient length of time to enable me to obtain an image.

"The advantages of using bromine in the place of iodine, for all objects having a green or yellow colour, have been already pointed out."

The sensibility of the preparations employed by the Count de Montizon, enabling him to obtain photographs of most of the living animals in the Zoological Gardens, renders his processes of interest. He employs the following preparations:—

1st, In one ounce of collodion, put a little iodide of silver, and about three or four grains of iodide of potassium, and then shake it well up. The collodion becomes very turbid, but on being left for some hours, it gradually clears up, beginning at the bottom. When it is quite clear, pour off the liquid into another bottle.

2d, To one ounce of collodion add two grains of iodide of ammonium. This will give very beautiful gradation in the half-tones, but not so vigorous a picture as the first.

3d, In eight drachms of pure alcohol dissolve perfectly eight grains of iodide of ammonium or iodide of potassium and ½ grain of iodide of silver; then add twenty-four drachms of collodion. The iodide of silver ought to be freshly made, or the resulting negative will be of inferior quality. The iodide of ammonium too ought to be newly made. This collodion is one of the most sensitive, but the half-tones produced by it are inferior.

4th, In eight drachms of alcohol dissolve eight grains of iodide of potassium, four of iodide of ammonium, and ½ grain of iodide of silver; then add twenty-four drachms of collodion. This forms a very sensitive medium.

5th, In 2½ ounces of collodion, five drachms of alcohol and five minims of liquid ammonia, dissolve fourteen grains of iodide of ammonia. This forms a very good collodion, very sensitive and colourless.

6th, In two drachms of alcohol dissolve six grains of iodide of potassium, and add six drachms of collodion.

We now come to the Count de Montizon's

Method of Operating.—I employ nothing but water to clean the glass plate with, using plenty of it, and rubbing the glass with the hand till the water flows freely over the surface. It must be well dried and rubbed clean with a linen cloth which has been well washed without the use of soap. When the collodion comes away from the glass, it is almost always in consequence of the existence of grease or dirt, or of a little moisture upon the surface.

Pour the collodion upon the glass in the usual way, and almost immediately immerse it in the bath of nitrate of silver, thirty grains to the ounce of water, lifting it in and out of the solution to allow the ether to escape. When it assumes a bluish-opal hue, it is ready for use. By adding a little alcohol to the solution, one part of alcohol to ten parts of water, and one part of nitrate of silver, the collodion is more speedily rendered sensitive and the image produced is more vigorous.

It seems of some importance to immerse the glass in the nitrate bath, and to place it in the slide in the same direction as that in which the collodion was poured off the glass plate.

After the appearance of the opal hue, if the bath be an old one, the plate may be left in it for some time without injury; but if the bath be new, it must not be left longer than is necessary to excite, or the nitrate would attack the iodide of silver.

To obviate this, it is well in making a new bath to add one grain of iodide of silver to each ounce of the nitrate solution.

It is unnecessary to filter the bath, as it is often altered in its nature by passing through paper containing injurious chemical constituents. A little blotting-paper drawn over the surface will remove any particles of dust that may be floating upon it.

If the bath contain alcohol, it should, when not in use, be kept in a stoppered bottle.

The Count de Montizon adopts the processes for development and fixing which have already been described.

We cannot consider our task finished without mentioning the addition of gutta percha to the collodion. This discovery was made by Mr. P. W. Fry, to which gentleman belongs some of the most important steps made in the art.

The sensibility of the plates appear to be most materially increased by the addition of the gutta percha; indeed, pictures by superposition may be obtained with absolute instantaneity, and in the camera obscura in less than a second of time.

The plan of proceeding to obtain this extreme sensibility, as recommended by Mr. Fry, is to obtain a thick and strongly charged collodio-iodide, and to two parts of this add one of a saturated ethereal solution of gutta percha, allowing it to stand a day or two to clear itself, previous to being used.

The plate is then coated in the usual manner. As the ether evaporates a peculiar white film comes over, at which time it is ready for immersion in the bath. This must be conducted as previously described, and, from its extreme sensibility, with, if possible, greater precaution than before.

For the development of negative pictures, Mr. Fry recommends the pyrogallic solution, rather stronger than that previously given, about one grain to the ounce, with the addition of an extra portion of acetic acid, and the plate *re-dipped in the nitrate bath*, in preference to adding silver solution to the pyrogallic acid.

In fixing the image after development, it is necessary to keep the hyposulphite longer than with the ordinary collodion, as the iodide is held with greater tenacity. In other respects the method of proceeding is precisely the same.

Mr. Thomas has modified the *collodion process* as follows:—

1st. To prepare the glass.—Roughen the surface of the edge about one-sixteenth of an inch all round with coarse emery paper; this prevents contraction of the film, and enables you to pump upon it, if necessary, without any fear of coming off.

2d. To clean the glass if new.—Make a mixture of spirits of wine and liquor ammonia equal parts, render it as thick as cream with tripoli; with a piece of cotton wool, kept for this purpose, rub a small quantity over that side scratched as described, wash well under a tap of water, and wipe dry with a piece of old linen washed without soap and kept scrupulously clean for this purpose.

N.B.—To clean a glass after having used it, when not varnished, wash off the collodion film with water, and dry as above. Always wipe the glass just before use, and breathe upon it; if clean, the moisture evaporates evenly.

3d. Pour into the centre as much collodion as the glass will hold, and pour off at that corner diagonal to the one by which the glass is held: prevent the formation of lines, by altering quickly the position of the glass before the film dries; with observation and practice dexterity is easily acquired.

4th. As soon as the collodion ceases to run, plunge the prepared glass, without stopping, into the following bath :—

Into a twenty ounce stoppered bottle put

Nitrate of silver, ...	1 ounce.
Distilled water, ...	16 ounces.
Dissolve.	
Iodide of potassium, ...	5 grains.
Distilled water, ...	1 drachm.
Dissolve.	

On mixing these two solutions a precipitate of iodide of silver is formed. Place the bottle containing this mixture in a saucepan of hot water, keep it on the hob for about twelve hours, shake it occasionally, now and then removing the stopper. The bath is now perfectly saturated with iodide of silver : when cold, filter through white filtering paper, and add,

Alcohol, ...	2 drachms.
Sulphuric æther, ...	1 drachm.

A convenient way of saturating the nitrate of silver bath with iodide of silver, is to dissolve the one ounce of nitrate of silver in two ounces of the water, add the solution of iodide of potassium to this strong solution ; the precipitate thus formed is by shaking entirely dissolved ; now add the remaining fourteen ounces of water, when the iodide of silver is again thrown down, but in such a finely divided state as to render the complete saturation of the bath more perfect, obviating the necessity of frequent shaking. After half-an-hour, add the alcohol and ether and filter.

5th. Allow the prepared glass to remain in this bath eight or ten minutes : just before taking it out move it up and down three or four times ; drain it, but not too closely ; when in the frame place upon the back a piece of common blotting-paper to absorb moisture ; the sooner it is placed in the camera the better.

6th. The time of exposure can only be ascertained by practice, no rules can be laid down, and I am unacquainted with any royal road but that of experience, leading to constant success in this most important section of photography.

7th. The plate being taken from the camera and placed upon a levelled stand, and develop instantly the latent image with the following solution :—

Pyrogallic acid, ...	3 grains.
Glacial acetic acid, ...	1 drachm.
Distilled water, ...	1 ounce.

Take one part of this solution and two parts of distilled water for use.

8th. When the image is sufficiently intense wash freely with common filtered water, then pour on the solution of hyposulphite of soda, wash, dry, and varnish in the usual manner.

In the third section of this work will be found a description of the most reeent methods recommended for keeping the sensitive eollodion plate during some time without injury, and all additional improvements in relation to this proeess, up to the latest period.

CHAPTER XIV.

THE CAMERA OBSCURA AND OTHER APPARATUS FOR THE COLLODION PROCESS.

It will be evident to all who have practised the simple forms of the Collodion process, that the ordinary construction of the camera obscura answers for this, as it does for the other processes. But for the practice of this photographic method in the open air, some modifications were required.

Many ingenious cameras have been devised for this purpose; but there are few better contrivances than that introduced by Mr. Archer, and modified by Messrs. Griffin & Co.

The following is a general description of the camera constructed by Mr. Archer, which admits of being made as a very light folding camera, if thought necessary.

It is a wooden box, eighteen inches long, twelve inches wide, and twelve inches deep, and is capable of taking a picture ten inches square. Externally it may be thus described:—In front it has a sliding door, with a circular opening in it, to admit the lens: this sliding door enables the operator to lower, or raise, the lens, and consequently the image formed by it, on the ground glass, as the view may require. The two sides of the camera have openings cut in them, into which sleeves of India rubber cloth are fixed, to admit the hands of the operator, and are furnished with India rubber bands at the lower ends, which press against the wrists, and prevent the admission of light.

The back of the camera has a hinged door fitted at its upper part with an opening of just sufficient size for the eyes, and shaped so as to fit close to the face. A black cloth is tied round this end of the camera, to prevent any ray of light penetrating at this opening. In the top of the camera, near the front, is inserted a piece of yellow glass, to admit a small quantity of yellow light, and is closed with a hinged door, to regulate the quantity of light required.

The interior of the box is furnished with a sliding frame, to support the ground glass or the bath and the prepared plate; and it has a stop, by means of which any focus from three inches to fifteen inches can easily be obtained.

The bottom of the camera is furnished with a gutta percha tray, about one inch deep, to hold the washings, &c., when the camera is in operation,

Also, the bottom of the camera at the back has an opening cut in it, extending nearly the whole width of the camera, and as far in as the edge of the gutta percha tray.

This opening is intended to admit, when the camera is in use, a light wooden case containing the glass bath, focusing frame, stock of glass, and paper required in the process.

This form of camera will admit of the following manipulation:—Having placed it upon a stand pointing to the object to be taken, the hinged door at the back is opened, and the bath is three parts filled with the solution of nitrate of silver; a plate of glass is then taken from the cell, and cleaned if necessary.

The collodion is poured on in the manner previously described; when the film has set a little it is immersed in the nitrate of silver bath, and the lid of the bath is closed down upon it. The next step is to obtain the focus with the ground glass: this can be done whilst the collodion is becoming iodized.

After adjusting the sliding frame to the proper focal distance, the camera must be closed, and the rest of the process conducted by passing the hands through the sleeves, and placing the eyes close to the aperture in the back of the camera, and drawing the black cloth over the front of the head.

By the aid of the yellow light admitted from the top, the operator can carry on the rest of the process. The plate is now ready for the action of light, and is taken from the bath; or the bath itself, with the plate in it, is placed in the sliding frame. The refracted image is at once thrown upon the sensitive plate. After the requisite exposure, the plate is taken from the bath, and the picture is developed with the solution previously described. The progress of this operation can be seen by aid of the yellow light, keeping the eyes close to the aperture behind.

When, from experience, the picture is sufficiently brought out, a little water is poured on the glass to wash off the developing solution, and the drawing is partially fixed by the application of a small quantity of a solution of common salt.

The drawing may now be removed from the camera without fear of being injured by light, and the remainder of the operations can be conducted outside the camera.

The advantages of a camera of this kind may be thus enumerated.

It allows the preparation on the spot of the most sensitive surfaces; their immediate use whilst the sensibility is at its maximum; the ready development of the image, and fixing.

All these operations being carried on consecutively, the operator can, after the first trial, see what results the progress of his labours is likely to produce.

It gives him the power of shading off any portions of the view during the action of the light, by holding in front of the prepared plate and near the lens a moveable screen, or any flat piece of wood, as the case may require; thereby preventing the too rapid action and consequent solarization of the distant portions of the scene. The spire of a church, for instance, pointing upwards into a bright sky, often requires this precaution to prevent its being entirely lost. Other instances of this effect will readily suggest themselves to those at all acquainted with the art.

The following figures represent Mr. Archer's camera with some modifications.

The figure 40 is a section of the camera, and 68 its external form, *a* is the sliding door that supports the lens *b*. *c c* are the side openings fitted with cloth sleeves to admit the operator's arms. *d* is a hinged door at the back of the camera, which can be supported like a table by the hook *e*. *f* is the opening for looking into the camera during an operation. This opening is closed, when necessary, by the door *g*, which can be opened by the hand passed into the camera through the sleeves *c*. The yellow glass window which admits light into the camera during

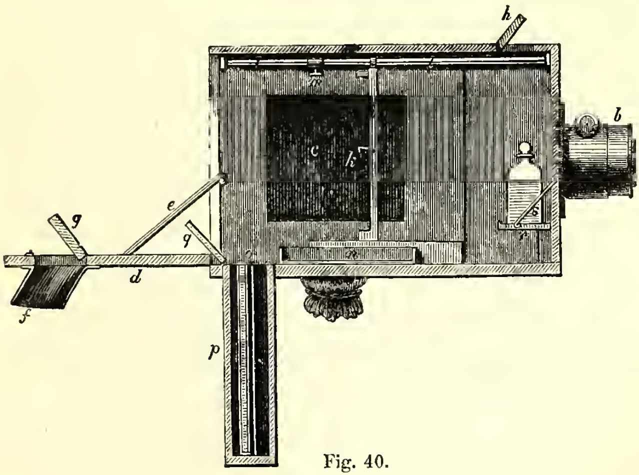

Fig. 40.

an operation is under the door *h*. *i* is the sliding frame for holding the focusing glass, or the frame with the prepared glass, either of which is fastened to the sliding frame by the check *k*. The frame slides along the rod *l*, *l*, and can be fixed at the proper focus by means of the step *m*. *n* is the gutta percha washing tray. *o* is an opening in the bottom of the camera near the

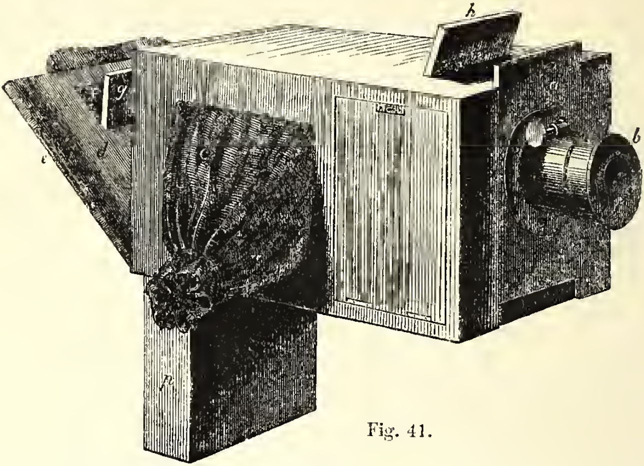

Fig. 41.

door, to admit the well *p*, and which is closed, when the well is removed, by the door *q*. The well is divided into two cells, one of which contains the focusing glass, and the other the glass trough, each in a frame adapted to the sliding frame *i*. On each side of the sliding door that supports the lens *a*, there is, within the camera, a small hinged table *r*, supported by a bracket *s*. These two tables serve to support the bottles that contain the solutions necessary to be applied to the glass plate after its exposure to the lens.

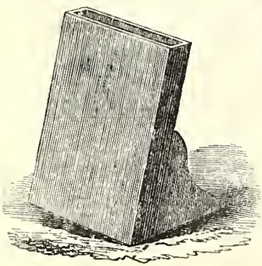

Fig. 42.

Previously to describing the forms of camera obscura which are more especially recommended for the collodion process—and which are, of course, peculiarly adapted to any form of photographic manipulation—it may assist the amateur if a few of the more convenient forms of apparatus are described.

Fig. 42 represents the ordinary folding gutta percha dipping bath, which is supported at a convenient angle, to avoid the removal of the sensitive film from the surface of the glass as it is withdrawn from the silver solution.

Fig. 43 is a glass dipper, with the collodion plate supported on it for the purpose of carrying it conveniently into the troughs.

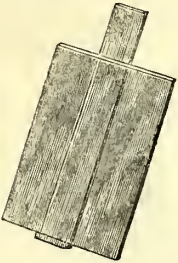

Fig. 43.

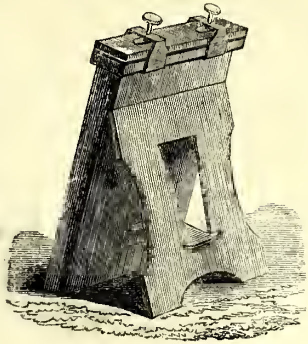

Fig 44.

When operating in the open air, or at a distance from home, bottles for holding the solutions become inconvenient. The following form of trough (fig. 44) has, therefore, been constructed for the purpose of carrying with safety the silver solution. This trough is of gutta percha; the head is partly of mahogany, secured by brass screws; close contact is insured by means of a piece of vulcanized caoutchouc, but this is kept from contact with the solutions of silver, by the interposition of a piece of gutta percha. In this way the fluid is kept in a perfectly tight vessel until it is required for use; the head is readily removed by unscrewing the clamps, and as readily readjusted.

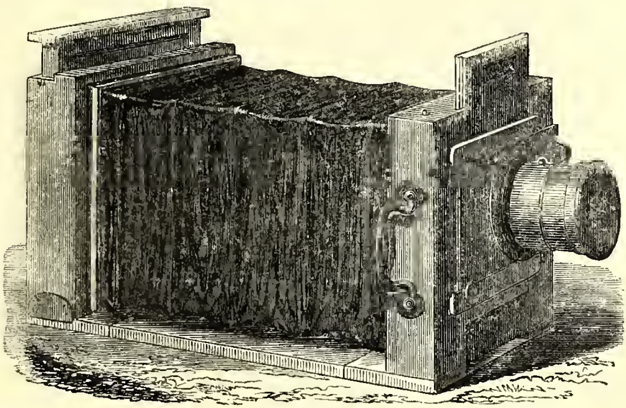

Fig. 45.

Fig. 45 shows a remarkably convenient form of camera obscura for use in the country. The inconvenience of a large box to the photographic traveller is exceedingly great. This is obviated by Judge's flexible camera. It will be seen by the drawing, that by means of a flexible bag, like that attached to the accordion, means are furnished for expanding the instrument to its required size for landscapes; or it may be contracted to the limits shown in the next figure (46), where it is folded for travelling.

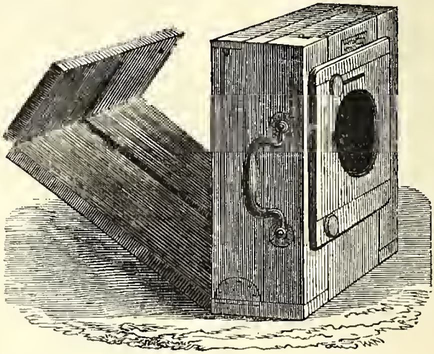

Fig. 46.

This camera has a double shifting front, by means of which the lenticular image can be thrown upon the screen, as may be desired, without disturbing the horizontality of the instrument.

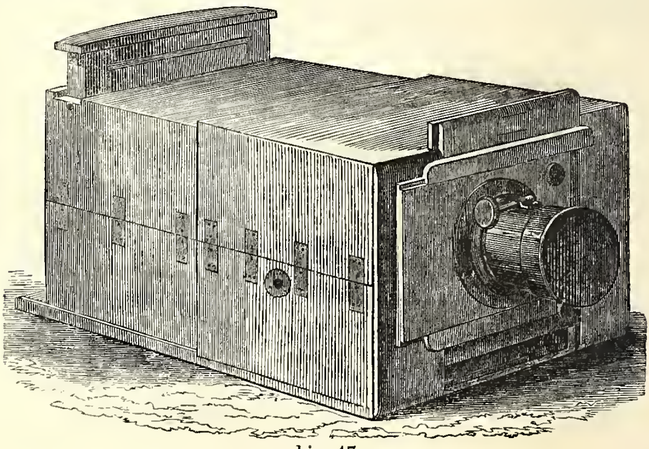

Fig. 47.

The camera obscura (fig. 47) is also intended for landscapes, and it has the advantage of *folding* and *sliding;* by the latter arrangement some of the advantages of correct focusing are insured. In the ordinary form of folding camera, the focus adjustment is limited to the rack movement on the brass work holding the lenses. It not unfrequently happens that alterations of focal distance, or a wider range than this allows of, is required. By the sliding arrangement in this form of the instrument all these desired advantages of adjustment are secured.

The next figure (48) is of a camera obscura for taking por-

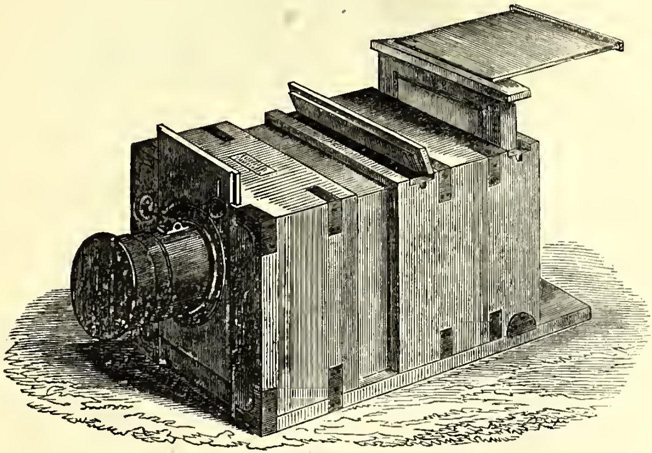

Fig. 48.

traits, with the convenient sliding arrangement. It is, in addition, constructed with double opening, so that it can be applied for taking landscapes as well as portraits.

Before quitting the subject of cameras, attention should be directed to the following stereoscopic camera obscura. On referring to the chapter on the Stereoscope, it will be learnt that the necessary pictures are obtained by taking two views at angles, differing in the same degree as the angle formed by the two eyes. In the camera (fig. 49) there is an arrangement, shown at *a*, *a*, for moving the body of the camera from side to side, so as to secure the proper distance for the views.

Steady supports for the camera obscura are important. In those represented (figs. 50, 51, 52), the heads, to which the camera screws when in use, can be taken off, and the legs fold closely together. In the third is shown a very firm stand for use at home, especially for portraiture, in which are arrangements for adjusting height, and other necessary movements.

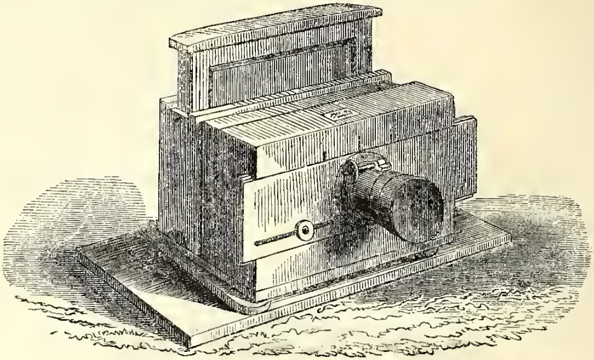

Fig. 49.

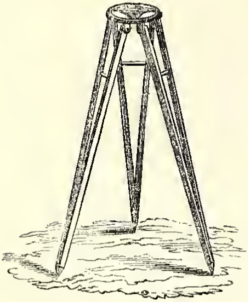

Fig. 50.

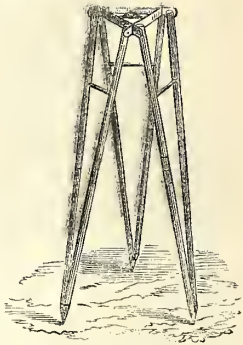

Fig. 51.

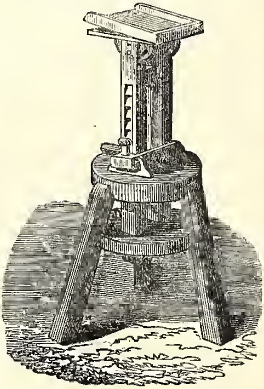

Fig. 52.

Fig. 53 shows a tripod stand and washing dish, upon which the collodion plate is placed for developing, washing, &c.

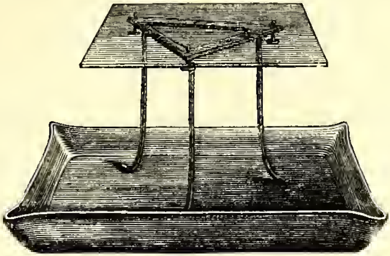

Fig. 53.

Another form of plate-holder, which is known as the lever pneumatic plate-holder, is shown at fig. 54.

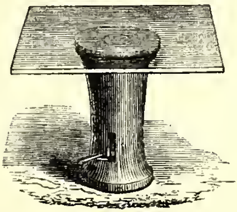

Fig. 54.

The picture being finished, it becomes necessary to multiply the picture obtained by copying, by superposition. The best form of pressure frame is that represented, fig. 55. In this

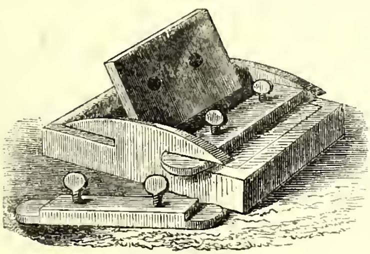

Fig. 55.

instrument the back opens in two pieces, so as to admit of the examination of the picture without disturbing either the negative or positive.

CHAPTER XV.

THE CYANOTYPE, CHRYSOTYPE, CHROMOTYPE, &c.

We are especially indebted to Sir John Herschel for an important series of investigations on a great variety of photographic agents. Of these researches an especial description will be given in the Third Section of this volume. In the present place one or two pleasing photographic processes must, however, be described.

The Cyanotype process depends upon the power of sunshine to change a persalt of iron into a protosalt, and on the different properties of these two oxides in relation to the ferro-prussiate of potash.

Paper is washed over with a solution of the ammonia citrate, or the ammonia tartrate of iron (the citrate, tartrate, or the per-sulphate will answer, but the final results are not so good).

Ammonia citrate of iron, . .	40 grains.
Water, ...	1 fluid ounce.

The surface being perfectly uniform, is dried; it may be kept in a portfolio for some weeks without injury. This paper is used in the ordinary way. Any object superposed is copied as a negative by an exposure varying from ten to twenty minutes, according to the intensity of sunshine. On removing the paper from the pressure frame, a yellow image of the superposed body appears in contrast with a brown surface. All the parts exposed are changed brown, by the decomposition of the iron salt. If the paper is now soaked in water, it will be found that the yellow parts dissolve out, but that the brown parts remain unchanged.

If, however, the picture, without being washed with water, is treated with a strong solution of the ferrocyanide of potassium, all the exposed parts become blue, which is considerably exalted by subsequent soaking in a solution of carbonate of soda, which serves at the same time to dissolve out the unchanged salt, and to permanently fix the photograph.

The Chrysotype is the same as the Cyanotype in all its details, but that the photograph after exposure is washed with a solution of the chloride of gold, as neutral as possible. We thus obtain a picture formed by the purple oxide of gold on the white surface of the paper.

Pictures of this description are exceedingly pleasing; but, owing to the want of sensibility in the iron salts, there are not many purposes to which either of those processes can be applied.

The *rationale* of these processes will be fully described, and several modifications given, in the division devoted to an examination of the science of the subject.

Bichromate of Potash.—There are many preparations which are affected by light in a similar manner to the salts of silver. Several have been tried as photographic materials, but as yet without much success, with the exception of the bichromate of potash, which was first announced as a useful photographic agent by Mr. Mungo Ponton, in the *Edinburgh New Philosophical Journal;* from which I quote Mr. Ponton's own account:—

"When paper is immersed in the bichromate of potash, it is powerfully and rapidly acted on by the sun's rays. When an object is laid in the usual way on this paper, the portion exposed to the light speedily becomes tawny, passing more or less into a deep orange, according to the strength of the light. The portion covered by the object retains the original bright yellow tint which it had before exposure, and the object is thus represented yellow upon an orange ground, there being several gradations of shade, or tint, according to the greater or less degree of transparency in the different parts of the object.

"In this state, of course, the drawing, though very beautiful, is evanescent. To fix it, all that is required is careful immersion in water, when it will be found that those portions of the salt which have not been acted on by the light are readily dissolved out, while those which have been exposed to the light are completely fixed on the paper. By the second process the object is obtained white upon an orange ground, and quite permanent. If exposed for many hours together to strong sunshine, the colour of the ground is apt to lose its depth, but not more so than most other colouring matters. This action of light on the bichromate of potash differs from that upon the salts of silver. Those of the latter which are blackened by light are of themselves insoluble in water, and it is difficult to impregnate paper with them in a uniform manner. The blackening seems to be caused by the formation of oxide of silver.

"In the case of the bichromate of potash, again, that salt is exceedingly soluble, and paper can be easily saturated with it. The agency of light not only changes its colour, but deprives it of solubility, thus rendering it fixed in the paper. This action appears to consist in the disengagement of free chromic acid, which is of a deep red colour, and which seems to combine with the paper. This is rendered more probable from the circumstance that the neutral chromate exhibits no similar change. The best mode of preparing paper with bichromate of potash is to use a saturated solution of that salt; soak the paper well in it, and then dry it rapidly at a brisk fire, excluding it from daylight. Paper thus prepared acquires a deep orange tint on exposure to the sun. If the solution be less strong, or the drying less rapid, the colour will not be so deep. A pleasing variety may be made by using sulphate of indigo along with the bichromate of potash, the colour of the object and of the paper being then different shades of green. In this way, also, the object may be represented of a darker shade than the ground."

Paper prepared with the bichromate of potash, though as sensitive as some of the papers prepared with the salts of silver, is much inferior to most of them, and is not sufficiently sensitive for the camera obscura. This paper, however, answers quite well for taking drawings from dried plants, or for copying prints. Its great recommendation is its cheapness, and the facility with which it can be prepared.

As the deep orange ground of these pictures prevents the permeation of the chemical rays of light, it is very easy to procure any number of fac-similes of an engraving, by transfer from the first negative photograph. The correct copies have a beautiful sharpness; and, if carefully managed, but little of the minute detail of the original engraving is lost.

A photographic paper prepared with the bichromate of potash of another kind is described by M. E. Becquerel. He states,—It is sufficient to steep a paper prepared in Mr. Ponton's manner, and upon which there exists a faint copy of a drawing, in a solution of iodine in alcohol, to wash this paper in alchohol, and then dry it; then the parts which were white become blue, and those which were yellow remain more or less clear.

M. E. Becquerel has pursued his investigation into the action of the chromic acid on organic compounds, and has shown that the mode of sizing the papers influences their coloration by light, and that with unsized paper coloration is effected only after a long time. Perceiving that the principal reaction resulted from the chromic acid contained in the bichromate of potash on the starch in the size of the paper, it occurred to M. E. Becquerel, that, as starch has the property of forming with iodine a combination of a very fine blue colour, it should produce deep shades of that tint, whilst the lights still remained an orange-yellow.

His method of proceeding is to spread a size of starch very uniformly over the surface of the paper. It is then steeped in a weak alcoholic solution of iodine, and afterwards washed in a great quantity of water. By this immersion it should take a very fine blue tint. If this is uniform, the paper is considered fit for the experiment; in the contrary case it is sized again. It is then steeped in a concentrated solution of bichromate of potash, and pressed between folds of blotting-paper, and dried near the fire. To be effective, it should be very dry.

It is now fit for use. When the copy is effected, which requires in sunshine about five minutes, the photograph is washed and dried. When dry, it is steeped in a weak alcoholic solution of iodine, and afterwards, when it has remained in it some time, it is washed in water, and carefully dried with blotting-paper, but not at the fire, for at a little below 100° Fahr. the combination of iodine and starch discolours.

If it be considered that the drawing is not sufficiently distinct, this immersion may be repeated several times; for by this means may be obtained the intensity of tone that is desired, which intensity can be changed at will by employing a more concentrated solution of iodine.

When the paper is damp, the shades are of a very fine blue, but when it is dry the colour becomes deep violet. If while the drawing is still wet it be covered with a layer of gum arabic, the colour of the drawing is greatly preserved, and more beautiful when it is dry. When a paper is thus prepared, it loses at first a little of its tone, but it afterwards preserves its violet tint.

The Chromatype.—This process, devised by the author, is a pleasing one in its results: it is exceedingly simple in its manipulatory details, and produces very charming positive pictures by the first application. The chromatype is founded on the above process of Mr. Ponton's:—

One drachm of sulphate of copper is dissolved in an ounce of distilled water, to which is added half-an-ounce of a saturated solution of bichromate of potash; this solution is applied to the surface of the paper, and, when dry, it is fit for use, and may be kept for any length of time without spoiling. When exposed to sunshine, the first change is to a dull brown, and if checked in this stage of the process we get a negative picture, but if the action of the light is continued, the browning gives way, and we have a positive yellow picture on a white ground. In either case, if the paper, when removed from the sunshine, is washed over with a solution of nitrate of silver, a very beautiful positive picture results. In practice it will be found advantageous to allow the bleaching action to go on to some extent; the picture resulting from this will be clearer and more defined than that which is procured when the action is checked at the brown stage. To fix these pictures it is necessary to remove the nitrate of silver, which is done by washing in *pure* water; if the water contains any muriates the picture suffers, and long soaking in such water obliterates it, or if a few grains of common salt are added to the water, the apparent destruction is very rapid. The picture is, however, capable of restoration; all that is necessary being to expose it to sunshine for a quarter of an hour, when it revives; but instead of being of a red colour, it becomes lilac, the shades of colouring depending upon the quantity of salt used to decompose the chromate of silver which forms the shadow parts of the picture.

Mr. Bingham remarks on this process that if we substitute sulphate of nickel for the sulphate of copper, the paper is more sensitive, and the picture is more clearly developed by nitrate of silver.

The following modification of this process possesses some advantages. If to a solution of the sulphate of copper we add a solution of the neutral chromate of potash, a very copious brown precipitate falls, which is a true chromate of copper. If this precipitate, after being well washed, is added to water acidulated with sulphuric acid, it is dissolved, and a dichromatic solution is formed, which, when spread upon paper, is of a pure yellow. A very short exposure of the papers washed with this solution is quite sufficient to discharge all the yellow from the paper, and give it perfect whiteness. If an engraving is to be copied we proceed in the usual manner; and we may either bring out the picture by placing the paper in a solution of carbonate of soda or potash, by which all the shadows are represented by the chromate of copper, or by washing the paper with nitrate of silver. It may sometimes happen that, owing to deficient light, the photograph is darkened all over when the silver is applied; this colour, by keeping, is gradually removed, and the picture comes out clear and sharp.

If the chromate of copper is dissolved in ammonia, a beautiful green solution results, and if applied to paper acts similarly to those just described.

The chromatype pictures, under certain conditions, afford a beautiful example of the changes which take place, slowly, in the dark, from the combined operations of the materials employed.

If we take a chromatype picture after it has been developed by the agency of either nitrate of silver, or of mercury, and place it aside in the dark, it will be found, after a few weeks, to have darkened considerably both in the lights and shadows. This darkening slowly increases, until eventually the picture is obliterated beneath a film of metallic silver or mercury; but, while the picture has been fading out on one side, it has been developing itself on the other, and a very pleasing image is seen on the back. After some considerable time the metal on the front gives way again, the paper slowly whitens, and eventually the image is presented on both sides of the paper of equal intensity, in a good neutral tint upon a gray ground.

The Ferrotype.—This process, which is of remarkable sensibility, was discovered by the author, and published in the *Athenæum*, under the name of the Energiatype ; but from a desire to group all those pictures into which iron salts enter as an element under a general head, the present name is preferred. The preparation of the paper is as follows:—Good letter-paper (Whatman's is the best) is washed over with the following solution, viz., Five grains of succinic acid (it is important that succinic free from any oil of amber, or adventitious matter should be obtained) are to be dissolved in one fluid ounce of water, to which are added about five grains of common salt, and half a drachm of mucilage of gum arabic. When dry, the paper is drawn over the surface of a solution of sixty grains of nitrate of silver in one ounce of distilled water. Allowed to dry in the dark, the paper is now fit for use, is of a pure white, retains its colour, and may be preserved for a considerable time in a portfolio, until wanted for use.

The preparation of this paper is by no means difficult, but requires care and attention. The solutions must be applied very equally over the paper, which should be immediately hung upon a frame to dry. Extreme care must be taken that the paper be not exposed to the least light, after the nitrate of silver solution has been applied, until required for use. Many of the disappointments experienced by the experimenters on the FERROTYPE are occasioned by a neglect of this precaution ; as, although no apparent effect may have been produced by the exposure, the clearness of the subsequent picture will be seriously injured. The succinic acid must also be very pure. We shall now briefly describe the method of applying this process to the different purposes for which it is best adapted, premising that the varying circumstances of time, place, and light, will render necessary such modifications of the following directions as the experience of the operator may suggest. As a general rule, an open situation, sunshine, and, if possible, the morning sun should be preferred, as the image is sharper, and the colour produced more intense, and less affected by the subsequent fixing process.

In the camera, for a building or statue, an exposure of half a minute in strong sunshine is usually sufficient ; for a portrait, taken under ordinary conditions, two or three minutes are required.

When the paper is taken from the camera, nothing is visible upon it; but by attending to the following directions the latent picture will quickly develop itself. Having mixed together about one drachm of a saturated solution of *proto-sulphate of iron* and two or three drachms of *mucilage of gum arabic*, pour a small quantity into a flat dish. Pass the prepared side of the paper taken from the camera rapidly over this mixture, taking care to insure complete contact in every part. If the paper has been sufficiently impressed, the picture will almost immediately appear, and the further action of the iron must be stopped by the application of a soft sponge and plenty of clean water. Should the image not appear immediately, or be imperfect in its details, the iron solution may be allowed to remain upon it a short time; but it must then be kept disturbed, by rapidly but lightly brushing it up, otherwise numerous black specks will form and destroy the photograph. Great care should be taken that the iron solution does not touch the back of the picture, which it will inevitably stain, and, the picture being a negative one, will be rendered useless as a copy. A slight degree of heat will assist the development of the image where the time of exposure has been too short.

The picture should be carefully washed to take off any superficial blackness, and may then be permanently fixed by being soaked in water to which a small quantity of ammonia, or, better still, hyposulphite of soda, has been added. The paper must again be well soaked in clean water to clear it from the soluble salts, and may then be dried and pressed.

Exact copies of prints, feathers, leaves, &c., may be taken on the succinated paper by exposing them to the light in the copying frame, until the margin of the prepared paper, which should be left uncovered, begins to change colour very slightly. If the object to be copied is thick, the surface must be allowed to assume a darker tint, or the light will not have penetrated to the paper.

Positive copies of the camera negatives are procured in the same manner as copies of the prints, &c., just described. Instead, however, of using the iron solution, the paper must be exposed to the light, in the frame, a sufficient time to obtain perfect copies. The progress of the picture may be observed by turning up the corner of the paper, and, if not sufficiently done, replacing it exactly in the same position. They should be fixed with hyposulphite, as before directed.

At the meeting of the British Association, at York, in 1844, I showed, by a series of photographs, that the *protosulphate of iron* was most effective in developing any photographic images, on whatever argentiferous preparation they may have been received.

Every subsequent result has shown that with proper care it is the most energetic agent for developing with which we are acquainted. The difficulty of obtaining, and of preserving, the salt free of any peroxide, or a basic salt which falls as a brownish-yellow powder, has been the principal cause why it has not been so generally employed as the gallic acid. This can be insured by adding a few drops of sulphuric acid and some iron filings to the solution of the proto-sulphate of iron.

The Catalysotype.—This process of Dr. Wood's is capable of producing pictures of superior excellence. Owing to the inconstancy of the iodine compounds, it is a little uncertain, but, care being taken to insure the same degree of strength in the solutions, a very uniform good result may be obtained. The process and its modifications are thus described by the inventor:—

"Let well glazed paper (I prefer that called wove post) be steeped in water to which hydrochloric acid has been added in the proportion of two drops to three ounces. When well wet, let it be washed over with a mixture of syrup of iodide of iron half a drachm, water two drachms and a-half, tincture of iodine one drop.

"When this has remained on the paper for a few minutes, so as to be imbibed, dry it lightly with bibulous paper, and being removed to a dark room, let it be washed over evenly, by means of a camel-hair pencil, with a solution of nitrate of silver, ten grains to the ounce of distilled water. The paper is now ready for the camera. The sooner it is used the better; as when the ingredients are not rightly mixed it is liable to spoil by keeping. The time I generally allow the paper to be exposed in the camera varies from two to thirty seconds; in clear weather, without sunshine, the medium is about fifteen seconds. With a bright light, the picture obtained is of a rich brown colour; with a faint light, or a bright light for a very short time continued, it is black. For portraits out of doors, in the shade on a clear day, the time of sitting is from ten to fifteen seconds.

"If the light is strong, and the view to be taken extensive, the operator should be cautious not to leave the paper exposed for a longer period than five or six seconds, as the picture will appear confused from all parts being equally acted on. In all cases, the shorter the time in which the picture is taken the better.

"When the paper is removed from the camera, no picture is visible. However, when left in the dark, without any other preparation being used, for a period which varies with the length of time it was exposed, and the strength of the light, a negative picture becomes gradually developed, until it arrives at a state of perfection which is not attained, I think, by photography produced by any other process.* It would seem as if the salt of silver, being slightly affected by the light, though not in a degree to produce any visible effect on it if alone, sets up a catalytic action, which is extended to the salts of iron, and which continues after the stimulus of the light is withdrawn. The catalysis which then takes place has induced me to name this process for want of a better word, the Catalysotype. Sir J. Herschel and Mr. Fox Talbot have remarked the same fact with regard to other salts of iron, but I do not know of any process being employed for photographic purposes, which depends on this action for its development, except my own.

"My reason for using the muriatic solution previous to washing with the iodide of iron is this: I was for a long time tormented by seeing the pictures spoiled by yellow patches, and could not remedy it, until I observed that they presented an appearance as if that portion of the nitrate of silver which was not decomposed by the iodide of iron had flowed away from the part. I then recollected that Sir J. Herschel and Mr. Hunt had proved that iodide of silver is not very sensitive to light, unless some free nitrate be present. I accordingly tried to keep both together on the paper, and after many plans had failed, I succeeded by steeping it in the acid solution, which makes it freely and evenly imbibe whatever fluid is presented to it. I am sure that its utility is not confined to this effect, but it was for that purpose that I first employed it.

"My reason for adding the tincture of iodine to the syrup is, that having in my first experiments made use of, with success, a syrup that had been for some time prepared, and afterwards remarking that fresh syrup did not answer so well, I examined both, and found in the former a little free iodine; I therefore added a little tincture of iodine with much benefit, and now always use it in quantities proportioned to the age of the syrup.

"The following hints will, I think, enable any experimenter to be successful in producing good pictures by this process. In the first place, the paper used should be that called wove post, or well glazed letter-paper. When the solutions are applied to it, it should not immediately imbibe them thoroughly, as would happen with the thinner sorts of paper. If the acid solution is

* The picture, when developed, is not readily injured by exposure to moderate light; it ought, however, to be fixed, which may be done by washing it with a solution of bromide of potassium, fifteen or twenty grains to the ounce, iodide of potassium, five grains to the ounce. It may either be applied with a camel-hair pencil or by immersion. The picture must then be well washed in water to remove the fixing material, which would cause it to fade by exposure to light.

too strong, it produces the very effect it was originally intended to overcome; that is, it produces yellow patches, and the picture itself is a light brick colour on a yellow ground. When the tincture of iodine is in excess, partly the same results occur; so that if this effect is visible, it shows that the oxide of silver which is thrown down is partly re-dissolved by the excess of acid and iodine, and their quantities should be diminished. On the contrary, if the silver solution is too strong, the oxide is deposited in the dark, or by an exceedingly weak light, and in this case blackens the yellow parts of the picture, which destroys it. When this effect of blackening all over takes place, the silver solution should be weakened. If it be too weak, the paper remains yellow after exposure to light. If the iodide of iron be used in too great quantity, the picture is dotted over with black spots, which afterwards change to white. If an excess of nitrate of silver be used, and a photograph immediately taken before the deposition of the oxide takes place, there will be often after some time a positive picture formed on the back of the negative one. The excess of the nitrate of silver makes the paper blacker where the light did not act on it, and this penetrates the paper; whereas, the darkening produced by the light is confined to the surface. The maximum intensity of the spectrum on the paper, when a prism of crown glass is used, lies between the indigo and blue ray. The difference of effect of a strong and weak light is beautifully shown in the action of the spectrum: that part of the paper which is exposed to the indigo ray is coloured a reddish-brown, and this is gradually darkened towards either extremity, until it becomes a deep black."

I have not had many opportunities of experimenting with the catalysotype, but it certainly promises to repay the trouble of further investigation. The simplicity of the process, and the sensibility of the paper, should cause it to be extensively used. It has all the beauty and quickness of the calotype, without its trouble, and very little of its uncertainty; and, if the more frequent use of it by me, as compared with the other processes, does not make me exaggerate its facility of operation, I think it is likely to be practised successfully by the most ordinary experimenters. Dr. Wood subsequently made the following addition:—

"Since the preceding paper was written, I have been experimenting with the catalysotype, and one day having had many failures, which was before quite unusual with me, I am induced to mention the cause of them, for the benefit of subsequent experimenters. The paper I used was very stiff and highly glazed, so that the solution first applied was not easily imbibed. The blotting-paper was very dry and bibulous. When using the latter, I removed nearly all the solution of iron from the first, and, of course, did not obtain the desired result.

"While varying the process in endeavouring to find out the cause just mentioned, I discovered that the following proportions gave very fine negative pictures, from which good positive ones were obtained :—Take of syrup of iodide of iron, distilled water, each two drachms; tincture of iodine, ten to twelve drops: mix. First brush this over the paper, and after a few minutes, having dried it with the blotting-paper, wash it over in the dark (before exposure in the camera) with the following solution, by means of a camel-hair pencil:—Take of nitrate of silver one drachm; pure water, one ounce, mix.

"This gives a darker picture than the original preparation, and consequently one better adapted for obtaining positive ones; it also requires no previous soaking in the acid solution. To fix the picture let it be washed first in water, then allowed to remain in a solution of iodide of potassium (five grains to the ounce of water), and washed in water again."

CHAPTER XVI.

GENERAL REMARKS ON THE USE OF THE CAMERA OBSCURA.—THE PHOTOGRAPHIC PENTAGRAPH.

The following remarks will apply with equal force to all the processes by which views of external objects can be obtained; but they have more especial reference to those highly sensitive ones, the Daguerreotype, the Talbotype, and the Collodion processes.

It has already been stated that a single achromatic lens, producing a large image, should be employed for motionless objects, where time is not of consequence. For a building, a statue, or the like, it is not of much consequence whether one minute or ten may be consumed in the operation of obtaining its impression. With the human figure and animals the case is very different: the utmost concentration of the solar radiations is therefore required to insure rapidity of action. This is effected by the double combination of lenses, which are usually mounted and adjusted as shown in the above figure, 56.

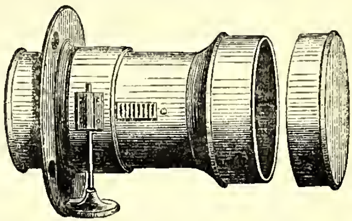

Fig. 56.

In fig. 57, the mounting of the single lens arrangement is shown.

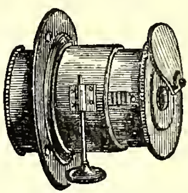

Fig. 57.

It is often of the utmost importance, to obtain definition of the objects, that all extraneous rays should be cut off; this is effected by means of a diaphragm of stops, which can be obtained to fit any lens. With this adjustment any sized aperture can be obtained.

Fig. 58 shows the double combination of lenses mounted for the purposes of photographic portraiture. The position of the double convex and of the meniscus lenses, in the double achromatic arrangement, should be carefully observed; and by attending to the remarks made in the Chapter on Lenses, it will become intelligible why this lenticular arrangement is necessary, for near objects, to produce that minuteness of detail which is desirable for effective portraiture.

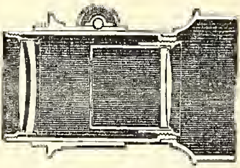

Fig. 58.

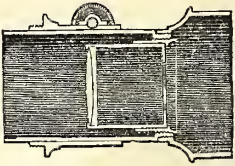

Fig. 59.

For the purposes of taking landscapes, the inner lens is taken out, and the front lens is placed so that the stop, which was in the first arrangement between the two achromatics, is in front of the lens (fig. 59). The convenience of this method of adjusting, so that the same camera obscura may be employed for either landscapes or portraiture, needs no recommendation.

Buildings, Statues, Landscapes, and Foliage.—The great defect in nearly all the photographic pictures which are obtained is the extreme contrast between the high lights and the shadows, and in many an entire absence of the middle tones of the picture.

In the very beautiful productions of Mr. Buekle, of Peterborough, which were displayed in the Great Exhibition, there was a very remarkable degree of fine definition, united with a beautiful blending of the respective parts which constituted the picture. There was no glaring contrast between the lights. Those parts which were the most brilliantly illuminated were softened into the middle tones of the picture, and those again faded gradually into the deep shadows. In the works of M. Martin and M. Flacheron, whose processes I have given, the same harmonizing of lights and shadows was generally found to exist.

The usual mistake with amateurs is that of selecting bright sunshine as the period for operating. It is thought, when a cathedral, for example, is brilliantly lighted up by sunshine, is the time for obtaining a photographic copy of it. A little reflection will convince the operator that this is the case only under particular conditions.

When the projecting parts of the building are flooded with sunshine, they cast the deepest possible shadows; consequently, in the photographic picture the prominent points would appear brilliantly white, and the shadows intensely dark.

It will be understood that I refer always to the *positive*, or completed picture.

A clear blue sky, reflecting its light upon a similar structure, produces less prominent illumination of the bold ornamental parts, and gives more light to those parts on which the shadows are cast. A photograph taken under such conditions of light and shade will be far more beautiful than the spotted productions which ordinarily result from the practice of operating when the sun is shining brightly on the object.

In the same manner, when the sun shines brightly on the leaves of trees, a very large quantity of light is reflected from their surfaces, the other parts appearing by contrast in almost absolute shadow. Hence, nearly all photographic views of forest scenery have more the appearance of scenes which have been sprinkled with snow than foliage glowing with sunshine.

An artist studies in his productions the most effective disposition of the lights and shadows, and it is by the harmonious disposition of these that he succeeds in giving a peculiar charm to his productions. Nearly all photographic pictures, although they have the merit of strict truthfulness, appear to want this great beauty of art. This has mainly arisen from the circumstance that intense illumination has been sought for under the idea of producing the sharpest picture; and it is true that thus we do obtain a very perfect definition of outline. Many productions are remarkable for this, and, indeed, reproduce with unnatural exactness all the minute details of the objects copied: whereas the human eye never sees this extraordinary sharpness of outline in nature; upon the edges of every object there are fringes of light which soften off their outlines, and subdue the general tone of objects, blending all harmoniously. Perhaps there is more than ordinary difficulty in producing this in a representation of nature which is effected by means of a lens. The artist may, however, do much: all times, even of bright illumination, are not fitted for producing a picturesque photograph. Nature should therefore be looked at with an artist's eye, and the happy moment chosen when the arrangements of light and shade give the most picturesque effects, and when these are in a condition to be correctly reproduced according to the laws by which actinic influences are regulated.

Portraits from the Life.—It is important for the production of a correct likeness that as small an aperture as possible should be used. By doing this there is great loss of light, and consequently the necessarily prolonged time must be compensated for by greatly increased sensibility in the plates.

It is also important that arrangements should be made to cut off from the lens all light proceeding from extraneous objects: this is best effected by the mode adopted by M. Claudet.

The camera is placed, as shown in section, fig. 60, within an arrangement of curtains which, as will be seen in the vignette

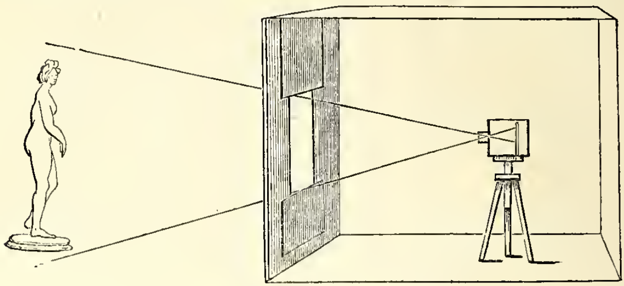

Fig. 60.

heading to this part, is capable of adjustment, so as to have any required opening in front of the camera. The whole of this screen being mounted on rollers is easily moved; therefore, the operator has it in his power to adjust the opening, and to shut off all adventitious radiations, thus securing the effectiveness of the rays proceeding directly from the sitter, or the object to be copied.

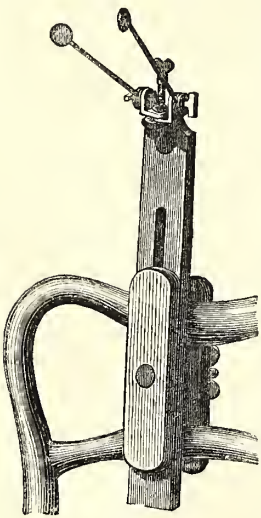

Fig. 61.

The sitter should be placed in the easiest possible position compatible with the arrangement of the body as nearly as is possible in a vertical plane. This is necessary, as the parts which are nearest the glass suffer a very considerable degree of distortion and enlargement. Of course, great steadiness is required on the part of the sitter during the few seconds he submits to the operation of the photographer. It is usual to support the head by a rest fastened to the back of the seat, as shown in fig. 61; but where the person can maintain a steady position without this, the result is generally the most satisfactory, the "rest" not unfrequently giving an air of stiffness to the sitter. In a great number of portraits a dark and unnatural shade is thrown under the eyes: this arises from the employment of a "top light." The light falling vertically produces a shadow of the brow over the eye, and gives a sombre character to the face. This is objectionable also, as being annoying to the sitter, who assumes in consequence a somewhat painful expression.

Those who have attended to the analyses of the spectrum, included in the scientific division of our subject, have become aware that the radiations from all coloured objects are not alike. A long description would not render this so apparent as a single illustration. Therefore, a group of flowers, including the three primary colours, and a few compound tints, will, when copied, be found to give effects almost directly opposed to the natural ones. Hence, it is of the utmost importance, particularly to ladies, that they should be directed to avoid in their dresses, when about to sit for their portraits, such colours as would produce darks for lights, and the contrary.

Photographic Pentagraph.—In a letter to Sir John Herschel, which was published in the *Athenæum*, Mr. Stewart directed attention to a means by which photographs could be readily enlarged. The plan had been in operation amongst photographic artists for some time, but it was not usually adopted, and Mr. Stewart's letter certainly brought it into general use. The following is Mr. Stewart's description of the required apparatus :—

"One of my friends here, Mr. Heilmann, has lighted on an ingenious method of taking from glass negatives positive impressions of different dimensions, and with all the delicate minuteness which the negative may possess. This discovery is likely, I think, to extend the resources and the application of photography,—and with some modifications, which I will explain, to increase the power of reproduction to an almost unlimited amount. The plan is as follows :—the negative to be reproduced is placed in a slider at one end (*a*) of a camera or other box, constructed to exclude the light throughout. The surface prepared for the reception of the positive—whether albumen, collodion, or paper—is placed in another slider, as usual, at the opposite extremity (*c*) of the box, and intermediately between the two extremities

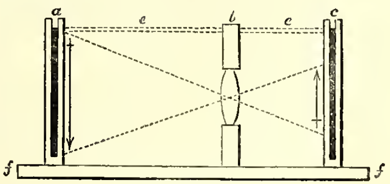

Fig 62.

(at *b*) is placed a lens. The negative at *a* is presented to the light of the sky, care being taken that no rays enter the box but those traversing the partly transparent negative. These rays are received and directed by the lens at *b* upon the sensitive surface at *c*, and the impression of the negative is there produced with a rapidity proportioned to the light admitted, and the sensibility of the surface presented. By varying the distances between *a* and *c*, and *c* and *b*, any dimension required may be given to the positive impression. Thus, from a medium-sized negative, I have obtained negatives four times larger than the original, and other impressions reduced thirty times, capable of figuring on a watch-glass, brooch, or ring.

"*a, c.* Slides to hold the frames containing the negative and the receiving surface for the positive.

"*b.* Frame with the lens.

"*e.* Dotted lines, indicating the top of the box or frame.

"*f,f.* Bottom board, or foundation of the same.

"Undoubtedly one of the most interesting and important advantages gained by this simple arrangement is, the power of varying the dimensions of a picture or portrait. Collodion giving results of almost microscopic minuteness, such negatives bear enlarging considerably without any very perceptible deterioration in that respect. Indeed, as regards portraits, there is a gain instead of a loss; the power of obtaining good and pleasing likenesses appears to me decidedly increased, the facility of subsequent enlargement permitting them to be taken sufficiently small, at a sufficient distance (and therefore with greater rapidity and certainty), to avoid all the focal distortion so much complained of; while the due enlargement of a portrait taken on glass has the effect, moreover, of depriving it of that hardness of outline so objectionable in a collodion portrait, giving it more artistic effect, and this without quitting the perfect focal point, as has been suggested.

"But there are many other advantages obtained by this process. For copying by engraving, &c., the exact dimension required of any picture may at once be given to be copied from.

"A very small photographic apparatus can thus be employed, when a large one might be inconvenient or impracticable, the power of reproducing on a larger scale being always in reserve. Independent of this power of varying the size, positives so taken of the *same* dimension as the negative, reproduce, as will be readily understood, much more completely the finer and more delicate details of the negatives, than positives taken by any other process that I am acquainted with.

"The negative also may be reversed in its position at *a*, so as to produce upon glass a positive to be seen either upon or under the glass. And while the rapidity and facility of printing are the same as in the case of positives taken on paper prepared with the iodide of silver, the negatives, those on glass particularly, being so easily injured, are much better preserved, all actual contact with the positive being avoided. For the same reason, by this process positive impressions can be obtained not only upon wet paper, &c., but also upon hard inflexible substances, such as porcelain, ivory, glass, &c.; and upon this last the positives being transparent, are applicable to the stereoscope, magic lantern, &c.

"By adopting the following arrangement, this process may be used largely to increase the power and speed of reproduction with little loss of effect. From a positive thus obtained, say on collodion, *several hundred* negatives may be produced either on paper or on albuminized glass. If on the latter, and the dimension of the original negative is preserved, the loss in minuteness of detail and harmony is almost imperceptible, and even when considerably enlarged, is so trifling as in the majority of cases to prove no objection in comparison with the advantage gained in size, while in not a few cases, as already stated, the picture actually gains by an augmentation of size. Thus, by the simultaneous action, if necessary, of some hundreds of negatives, many thousand impressions of the same picture may be produced in the course of a day.

"I cannot but think, therefore, that this simple but ingenious discovery will prove a valuable addition to our stock of photographic manipulatory processes. It happily turns to account and utilizes one of the chief excellences of collodion — that extreme minuteness of detail which, from its excess, becomes almost a defect at times—toning it down by increase of size till the harshness is much diminished, and landscapes, always more or less unpleasing on collodion from that cause, are rendered somewhat less dry and crude.

"A very little practice will suffice to show the operator the quality of glass negatives—I mean as to vigour and development —best adapted for reproducing positives by this method. He will also find that a great power of correction is obtained, by which overdone parts in the negative can be reduced and others brought up. Indeed, in consequence of this and other advantages, I have little doubt that this process will be very generally adopted in portrait-taking.

"Should your old idea of preserving public records in a concentrated form on microscopic negatives ever be adopted, the immediate positive reproduction on an enlarged readable scale, without the possibility of injury to the plate, will be of service."

There remains but little to add to this. As a general rule, it is advisable to use the same lens in the pentagraph as we are in the habit of employing in the camera obscura with which the photograph has been taken.

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